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THE

INTELLECTUAL OBSERVER

REVIEW OF NATURAL HISTORY,

MICROSCOPIC RESEARCH,

AND

RECREATIVE SCIENCE.

VOLUME VIII.

LONDON:

GROOMBRIDGE AND SONS,

PATERNOSTER ROW.

-1503-

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ILLUSTRATED WITH PLATES IN COLOURS AND TINTS, AND NUMEROUS
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MDCCCLXVI

HARRILD, PRINTER, LONDON.

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THE INTELLECTUAL OBSERVER.

AUGUST, 1865.

THE MEXICAN ZODIAC.

BY WILLIAM BOLLAERT, F.R.G.S.,

Corresponding Member of the University of Chile, etc.

(*With a Tinted Plate.*)

In the year 1790 a large stone Zodiac was discovered in the great square of Mexico, buried underground, amongst other ruins occasioned by the devastations of the Spanish conquerors. Gama, the Mexican astronomer, who has written on the subject, Humboldt, and several others, have published drawings of this remarkable relic, but none of them sufficiently complete in their details to serve the purposes of a critical and philosophical inquirer. A mere inspection of our plate will show that an artist would find the delineation of such an object an extremely laborious and difficult task, and without the aid of photography, a reliable copy would, in all probability, not have been obtained. The plate engraved to illustrate this paper is a reduced *fac simile* of a photograph about twelve inches in diameter, and it will be found to exhibit with distinctness the various symbolical objects which the original sculpture contains.

This Zodiac was carved at Tenantitlan out of a mass of finely porous basalt—a rock very common in the country—and was taken to the city of Mexico. On reaching the quarter of Xoloc, it broke from its bearings, and was precipitated into the lake, when the High Priest and many others were drowned. Being rescued from the water, it was transported to the temple of Huitzilopochtli, and its inauguration celebrated by awful sacrifices of prisoners captured in war. These sanguinary scenes took place in 1512, a few years before the arrival of Cortez and his companions.

The outer circle of the Zodiac is eleven feet eight inches in

diameter. Our engraving represents a full-face view, and consequently cannot display a slightly ornamented rim seven inches deep. This rim is, however, indicated by the shadow at the bottom, which the reader will observe. In order to understand the symbolical representations, it is necessary to remember that the Mexican year was divided into eighteen months of twenty days each, each month being named after some incident, or natural object, as will be presently explained.

The months were divided into weeks, not of *seven*, but of *five* days each, and the days of the month were designated by words signifying a sea animal, the wind, a house, a small lizard, a serpent, death, a deer, a rabbit, water, a dog, an ape, twisted grass, a reed, a jaguar, an eagle, a bird, the motion of the sun, silex or flint, rain, and a flower. The cardinal points were designated in the same singular method. Their first point was in the *east*, and represented by a cane, west was named a house, north a flint, and south a rabbit. Having made these preliminary remarks, we shall proceed to describe the circles of the Zodiac.

The several rings are nearly circularly drawn, but the bottom so-called "ray" is not equi-distant to the rays on either side of it.

The face in the centre is supposed to represent the sun. In the forehead are two circular bodies (all circles, dots, or ovals are intended for digits) having between them a figure with three curves, the sign of II Acatl (reed). This means the Reed, or thirteenth day of some month in the second year of the Mexican cycle of fifty-two years. From two circles, probably meant for ears, drop two ovals, containing nine circles and ovals in three lines, and one underneath, = 20, which is the number of days in the month. Underneath the chin, and on each side of the elongated tongue (symbol of speaking), there are six dots and ovals.

Within the next or second large circle are, first, four parallelograms, supposed to be in allusion to the belief that the sun had died four times. The first to the right represents IV Ocetotl (jaguar), answering in this place to our 22nd of May, in the first year of the cycle; the second, IV Atl (water); the third, IV* Quiahuitl (rain), 26th July; the fourth, Ehecatl (wind). These four symbols are also said to represent the four weeks of a month. The two lateral figures denote claws, said to be symbolical of two ancient astrologers, man and wife, who were represented as eagles or owls.

* The exact meaning of the numeral IV, as applied in these cases, is not quite understood.

The inverted V, called by Gama a triangle, at the top of the head, indicates the first and last day of the month. On the right is an oval symbol, which may be Echatl (wind); the one on the left probably represents Tepactli (silex). Underneath the tongue are two squares, each containing five indications = 10, which may belong to Ollin, or motion of the sun; to its right are circles and a head, or I Ozomatli (ape), 22nd of June, in the 26th year of the cycle; to the left is a figure called I Quiahuatl (rain), 22nd of March in same year of the cycle.

The third circle contains twenty divisions, representing, by Zodiacal signs, the twenty days of the month of the priests, which differed from the common month. These are read from the left, beginning under the left point of the upper ray. The signs of Sea Animal, Wind, House, Small Lizard, Serpent, Death, Deer, Rabbit, Water, Dog, Ape, Twisted Grass, Reeds, Jaguar, Eagle, Bird, Motion of the Sun, Silex, Rain and Flower. House, Rabbit, Reeds, Silex, stood in the middle of each small period of five days forming the weeks. A repetition of thirteen times of the above four would be equal to fifty-two, or the cycle of years.

Each of the eighteen months (not represented in this Zodiac) had its name, already alluded to, from some natural objects characteristic of the particular season, or from some festival or employment, as To glean. Trees bud. Victims flayed alive. Vigils of the priests. Grand Penitence. Garlands of Maize tied round the necks of the Idols. Food of Maize. Festival of Young Warriors. Festival of Old Warriors. Little Festival of the Dead. Great Festival of the Dead. A Broom-cleansing of Canals. A Parasitic Plant. Festival of Rural Divinities. Sacred Flamingo. Standard of one of the Principal Gods. Descent of Water and Snow.

In the fourth circle are a number of squares, each containing five indications = 190. It has heretofore been presumed that the four angular objects called rays covered twelve squares (but there is too much room for the said twelve squares); if so, the fifty-two squares, each containing five indications, would give 260, or the period of twenty-one series of thirteen days; however, I only make 190. I may observe that outside the 190 indications there are 70 of a doorway appearance; adding these two numbers, we get 260, which fact may be worth noticing.

The large angular objects, said to be sun's rays, may, I think, rather represent the four cardinal points. There are also four smaller angular sub-divisions, and four of a square form (somewhat like the sign for Tepactl or silex), making in

all sixteen divisions, which may have to do with the Mexican division of the day into sixteen parts.

Speaking of the outer circles, Gama says, "The external zone consists, except at the extremities, of a symbol twenty times repeated, which may represent the Milky Way. The waving lines are probably meant for clouds." Others suppose them to be symbols of mountains, in which clouds and storms originate; whilst Gallatin thought them to be altogether ornamental.

I will now examine this portion of the Zodiac. Between the large and small rays there are six sets of ten indications, and two of five (something like Acatl, or reeds) = 70, which number has been already referred to. Out of the centres of the six sets rise figures, called by Gama *"rafagas ó luces,"* which may mean plumes of feathers. These figures have squares with five indications each = 30, twelve of these would be = to 360. Then there are door-way indications, each of three, = 18, which may have to do with the eighteen months of the Aztec year.

Then follow the twelve series of the waved symbol (supposed by Gama to represent clouds and mountains), and underneath twelve open spaces of fours, = 48. The whole figure looks to me like the symbol Atl, or water. Did the Aztecs suppose that the world, as they knew it, was surrounded by water? One of their expressions was, "All the round world is but a sepulchre." Solis observes that one of their principal idols was seated in a chair, which was on a blue globe, which they called heaven. Out of this circle springs the symbol of the year XIII Acatl, or reeds (the twenty-sixth of the cycle).

We now come to the symbol on the outer edge, ten times repeated on each side, = 20. In the upper portions are band-like figures (which may be reeds), and probably have reference to the tying up, or completion of the cycle every fifty-two years. Further on are two more of these symbols, and in the lower portions two more partially covered, = 24. The twenty symbols have ten indications each, = 200. There were great feasts at every 200 and 300 days; but the symbols at the top have forty indications, and if the lower ones contained the same number, we should have 260 indications, or the number of days in the year of the priests, which had 100 days less than the solar year. Gama supposed this to be the symbol of the Milky Way; but it strikes me rather to represent plants or flowers. The first Spaniards called them tufts of flowers. I find the symbol to bear a great resemblance to that of the 20th, or last day of the month Xochtl, or Flower. May we suppose the Aztecs conceived that this was to represent the outside of

the circular plane of the world, and that it was an Elysium of green pastures and forests, the "happy hunting grounds" of the Indians of the north?

Pointing to XIII Acatl, the square symbol at the top of the plate, are two angular figures, which Gama says are merely indications of XIII Acatl. At their bases are objects like pillars, each supporting six rings or circles, = 12. Can this arrangement indicate the twelve solar months of the year?

In all this region, indeed, all round what I call the flower symbol, there are a series of diagonal lines, which may represent the sun's rays.

At the bottom are two lizard-looking figures; they have in Gama's drawing 86 dots and 104 lines, = 190. Gama calls the two profiles of heads at the bottom Tohnalteuhtli, which is the first name on the list of nine Lords of Night.

In a narrow circle near the edge are some sixty-five dots on each side, or 130, twice this = 260, the days of the year of the priests. In reference to the number 130, it may be stated here that Gama supposed the stone Zodiac was for six months of the year only, and that there was another for the other six months. He also thought one faced the north and the other the south. In this opinion I do not coincide.

Outside the above-mentioned circle, and running partially down the edge, are a series of oval indications, apparently 31 and 5 on one side, 32 and 5 on the other, = 73. Now there were 73 cycles of 260 days to form the cycle of fifty-two years, so that these ovals may have to do with this large cycle.

Eight holes, believed to be for gnomons, are found just outside the rim of ovals, and vertical to the surface of the stone. As this is so, I should conclude that the stone, when in position, was laid flat, and not upright, as Gama supposed.

Over the two heads (in Gallatin's drawing) are series of 24 and 21 indications, = 45 (twice 45 = 90 × 4 = 360). I make out 180 indications; this doubled, would give 360 for the days of the year, not including the five interculary days.

Gama observes that "we have delineated on this stone the dates of the five principal positions of the sun, from the vernal to the autumnal equinox. Three of these, the two transits of the sun by the Zenith (22nd May and 26th July), and the autumnal equinox (22nd September), are the Mexican days on which these phenomena occurred in the first year of the cycle (I Tochtli); and the two others, the vernal equinox (22nd March), and the summer solstice (22nd June), are the

Mexican days on which these two occurred in the XIII Acatl." He also informs us that this Zodiac is a true meridional clock, by means of which the Mexicans knew the eight intervals of the artificial day; four for the morning, and four for the evening, from the rising to the setting of the sun, as shown, most probably, by the shadows of the eight gnomons fixed *in the holes in* the circumference.

In the second lot of presents sent by Montezuma to Cortez, were two circular plates, one of gold, the other of silver, as large as carriage wheels. One, representing the sun, was richly carved, or in relief, "with tufts of plants and animals." It was valued at nearly £60,000. The silver wheel weighed some fifty lbs. At Tlascalá, with other presents from Montezuma, were "embossed gold plates" (Zodiacs). In a pond in Guatemozin's garden, the soldiers of Cortez found "a sun, as it was called;" this was one of the Zodiacs, or Aztec calendar wheels. Benvenuto Cellini saw some of these things, and was filled with admiration. They all went into the melting-pot centuries ago; but if they had been preserved, they might have assisted us in deciphering with accuracy the stone Zodiac which we have endeavoured to describe.

No pains have been taken to preserve the stone Zodiac from injury. It is now stuck in the wall of the tower of the cathedral, and has been exposed to the action of the weather and other causes of injury ever since its discovery. Thus some of the details we have described can with difficulty be made out at the present time; but by referring to the engraving illustrating Gama's rare work, published in Mexico at the beginning of this century, much aid is given. This drawing, though, as before remarked, not complete, was made when the Zodiac was in better condition than it has been for many years.

As very few Europeans have studied the curious subject of the astronomy of the Red Man, whose peculiar form of civilization reached its highest development, under diversified conditions, in the countries of Mexico and Peru, it may seem surprising that so much scientific knowledge should be imputed to them, as is involved in the descriptions of the stone Zodiac.

There can, however, be no doubt that the Red race arrived at a very considerable acquaintance with celestial phenomena. In Grave Creek Mound, Western Virginia, stone tubes have been found, supposed to have been intended for viewing the stars, after the manner practised by early oriental nations.

In ancient Mexico, where science was more advanced, the causes of eclipses were known. The learned men gave an

account of the great comets, especially the one of 1489. They also had a system of constellations, and were acquainted with four of the planets, including Venus. Gama describes an arrangement of three masses of stone at Chapultepuc, so arranged as to indicate east and west, and to show by shadows the exact time of the rising and setting of the sun at the period of the equinoxes and solstices, and the true mid-day during the year. In a late examination of the Pyramid of Xochichalco, or Hill of Flowers, an apartment was discovered, having a hole in its roof leading up to the summit of the pyramid, and so placed that it permitted the sun's rays to enter, and to fall, as tradition says, upon an altar at the exact date of the sun's crossing the tropics.

In Central America, the Red race constructed calendars bearing considerable resemblance to those of the Mexican, and in New Granada the Muisca natives engraved calendars on polished stone, usually in a pentagonal form, and their priests made lunar observations to regulate the division of time, their year consisting of twenty lunar months. Many details concerning them and kindred subjects will be found in my work on South American antiquities.* In Quito the Caranes conquered the ancient Quitus about 1000 A.D., and their chiefs, known as the Scyris, erected stone columns, which were used to observe the solstices, and regulate the solar year. They are said to have had twelve pilasters placed round their chief temple, serving as so many gnomons, to show the first day of each of their twelve months. These were most probably their own invention, and existed before their conquest by the later Incas of Peru. In Chile, the Araucanos distinguished planets from stars, took note of solstices and equinoxes, and grouped the stars into constellations. Their year was solar, consisting of 365 days. They also had a lunar year of twelve moons of thirty days each.

The Peruvians do not seem to have made as much progress in astronomy as the Mexicans; but their mechanical arrangements were highly curious. Eight cylindrical towers were erected to the east, and eight to the west of Cuzco. Each series of eight consisted of six large towers, in a straight line, with two smaller ones in the centre. The lines of towers were north and south, so that an observer stationed, say in the west group, could, by looking through the spaces, observe the sun rise between the opposite spaces between the towers of the east group. Some writers say there were twelve towers

* *Antiquarian, Ethnological, and other Researches in New Granada, etc.,* by Wm. Bollaert. Trübner and Co.

on each side; but in a gold calendar described by me in the work alluded to, the number of towers in a row is eight. These contrivances are believed to have indicated the solstices and other celestial phenomena. To discover the days of the equinox, they erected a stone column in an open area in front of their temple. This column was in the centre of a circle, and a line was drawn from east to west, and when the noon-day shadow of the pillar crossed this line at particular points, the equinoxes had arrived.

In January, 1864, Mr. D. Forbes presented me with a drawing of a small human figure in silver he had discovered in an ancient tomb in Bolivia.

The annexed woodcut represents the upper portion of this figure, and it will be seen that it is that of a man observing some celestial object through a hollow tube applied to the left eye. This is the first *undoubted* indication of a telescope tube being used in the new world, and gives probability to the supposition that those found in Grave Creek Mound were designed for a similar purpose.

GEOLOGICAL WORK OF FROST AND FIRE.*

The craft of reviewing has got into deplorable discredit in this country through the very shallow, or very untrustworthy opinions of books, or other productions, that too often occupy the pages of publications pretending to intelligence and impartiality. Some works are indeed difficult to describe fairly, and Mr. J. T. Campbell comes before us with two very beautiful and valuable volumes, in which merits and defects are alike conspicuous, so that it is far from easy to speak of them as they deserve. Sir Roderick Murchison, an excellent judge of such matters, speaks highly of *Frost and Fire*, and some critics have overwhelmed both the book and its author with preposterous praise. The truth, as we apprehend it, is that Mr. Campbell is a shrewd observer, and an admirable draughtsman of certain physical appearances which our globe presents, but his stock of scientific knowledge, though greater than he takes credit for, is by no means extensive, and he lacks the art of sustaining a pleasing, or methodical style. We should, therefore, describe his book as a collection of a hundred and seventeen beautifully executed and remarkably interesting sketches, chiefly illustrating the geological work performed by ice, and water set in motion by heat, accompanied by rambling, often crotchetty, and frequently clever descriptions of what he has seen, and how he interprets it. Most persons will, we think, find it tiresome to read his volumes through; but no one of scientific taste can fail to gain both pleasure and information from their pages. To the beginner they offer many shrewd hints and valuable suggestions, and the experienced geologist will welcome so large a collection of data of the highest importance in interpreting the history of our globe.

The fundamental idea of Mr. Campbell, and it is a good one, is that work, whether human or geological, is done with tools, and that tools leave their marks behind them wherever they have been employed. In the natural world two very important tools are, in his phraseology, "Frost and Fire," the glacier being the grandest exemplification of the one, and the volcano of the other. He does not take sufficient notice of the enormous amount of work performed by less striking agency, such as the quiet flow of rivers, the fall of rain, and the action of the air, hence his philosophy is incomplete, and his account of the modifications which terrestrial strata have experienced, wants the charm of due proportion in its several

* *Frost and Fire, Natural Engines, Toolmarks and Chips.* With Sketches taken at Home and Abroad, by a Traveller. 2 vols. Edmonston and Douglas.

parts. Such remarks, however, indicate his omissions, and we always deem it an ungracious thing when any one renders a decided service to science, to descant upon what he has left undone, instead of recognizing with becoming thankfulness what he has performed.

In an early part of Mr. Campbell's work some clever experiments are recommended as exhibiting to the eye the nature of the air and water currents which affect our globe. He recommends that a common aquarium, or oblong fish tank, shall be half filled with clear water, and placed in the sun. At one end a few lumps of rough ice are to be floated, and a black stone sunk at the other. When the water has settled, milk is to be poured gently on the ice at the rate of an ounce to each gallon of water in the tank. The sun's heat is absorbed by the black stone, and communicated to the adjacent water, producing an ascending current, while at the other end of the tank a descending current results from the cooling action of the ice. The milk, which if carefully poured in, mixes very slowly with the water, forms clouds whose movements indicate the currents and the amount of force by which they are impelled. "Cloud forms," says Mr. Campbell, "are copied with marvellous fidelity in this water toy, and, because the movement is very slow, they are easily seen and copied. But the tank gives a section of air as well as water. The miniature sea has an atmosphere, and the same forces work both engines. Let a bit of smouldering paper, tinder, rope, touchwood, or any such light combustible fall on the ice-raft, and cover the tank with a sheet of glass to keep in the smoke." By this means imitations of all sorts of natural clouds may be produced.

The same tank may be made to illustrate the movements of water about to freeze, when the apparatus is placed in a cold atmosphere. At one corner Mr. Campbell hangs a small thermometer, just dipping into the water; at the opposite corner he places another thermometer, with its bulb reaching the bottom, and capable of being elevated or depressed without making much disturbance. On some ice, floating near the centre of the water surface, he paints some lamp-black, sinks a globular block-tin bottle, filled with boiling water and corked, near the thermometer which touches the bottom, and covers one side of the tank with a screen of thin paper. When the ice begins to melt, the lamp-black begins to move. "If it is warmed by the sun, a dark revolving column sinks slowly down. But beneath the ice are layers which contain intricate patterns of curved lines of black, which bend and move slowly, but keep near the ice." "When a water-bottle, filled with hot water, coloured with lamp-black, is sunk through an ice dome without the stopper,

a warm dark column rises up like the spirit whom the Arabian fisherman let out of the copper vase. . . . . When the water is hot, a thing like a round-headed mushroom grows rapidly out of the neck, and takes all manner of strange shapes."

Experiments of this kind admit of indefinite variation. They can be performed with trifling expense, and are excellently adapted to explain the nature of actions by which climate is affected, and the superficial strata of the earth exposed to influences that modify their form.

Mr. Campbell's illustrations of "river marks" are very instructive, but he chiefly notices the violent action of tumbling streams. He does not omit quieter operations, as his clever sketch of Thames meanderings shows; but his favourite river theme is the mountain torrent, with its mark L in the rock which it cuts through. After mentioning many instances of this sort of action, he observes that "at the Devil's Bridge, near Aberystwith, a stream has sawed a groove in the blue slate. It is ninety feet deep, and about six wide. . . . . The rivulet has ploughed a groove at the bottom of a curve; it has turned V into Y."

After studying the river marks, the next step is to learn those of large floating ice masses and glaciers; and for students who cannot travel as extensively as Mr. Campbell has done, his sketches will prove an invaluable substitute. The glacier leaves its characteristic tool marks. "Wherever it goes the ice tool grinds; it works broken stones into polished boulders, boulders into mud, fractured rocks into *rôches moutonnées,* and mountain glens into rounded, polished, striated rock grooves, whose ground section is a curve ◡. When the ice melts, floating chips are left in the groove in their order."

Mr. Campbell gives a good description of the various tool marks left by moving masses of ice. The ice may polish rock surfaces; it may mark them with striæ, or scratch them with sand lines, or score them, or groove them, or make deep grooves, or hollows, or glens, or in passing over rocks that wear unequally, it may give them a bossy or mammillated form, and thus make *rôches moutonnées.* Very characteristic sketches of these several effects are given in the two volumes of *Frost and Fire.*

No geologist doubts that great masses of floating ice, such as can now be studied in Polar regions, and huge glaciers, of which Switzerland, Norway, and other localities afford good specimens, were the kind of tools which in former ages did very extensive and important work in fashioning the surface of the globe. In many cases the "tool marks" are distinct enough to point clearly to their origin; but when certain

observers and writers go beyond the definite information conveyed by such markings, and ascribe to glaciers the function of digging all the gigantic hollows in which the great lakes of Europe and America now repose, we may prefer exercising due caution, and not be too ready to accept explanations which have rather the aspect of overriding a favourite hobby than that of calmly considering all the circumstances that have to be explained. There is a tendency in philosophers to follow a practice common amongst physicians, and to have their pet causes, just as the latter indulge in their favourite remedies. At one time it may happen that patients seeking medical aid are all mercurized, bismuthized, or iodized, according to the fashion of the hour, and in like manner geologists indulge in fiery or watery speculations, sometimes neglecting and sometimes exaggerating the action of any particular agency capable of forming or changing terrestrial rocks. Mr. Campbell is a decided worshipper of the spirits of ice. Within the limits we have indicated we highly esteem his labours, and in taking leave of his *Fire and Frost,* we wish him health and opportunity for further travel, and that he may bring home and publish as valuable a series of sketches as those which will give permanent importance to the work he has just produced.

PHOTOGRAPHY AT GREENWICH OBSERVATORY.

BY THOMAS W. BURR, F.R.A.S., F.C.S., ETC.

THE scientific operations carried on at the Royal Observatory are essentially of a practical and utilitarian character. Originally founded for the especial purpose of the improvement of navigation by the construction of accurate catalogues of stars and tables of the moon, it is highly to the credit of its successive directors that they have never been tempted to a diversion of its resources to objects more immediately attractive and likely to bring them fame and renown as discoverers of fresh heavenly bodies, or other additions to the wonders of astronomy.

It is to this steady devotion to the original purpose of the establishment that we are indebted for the great work of Flamsteed, his *Historia Cœlestis;* for the indefatigable observations of Bradley, and his great discoveries of aberration and nutation; the well-conceived plans and constant labours of Maskelyne, who started the *Nautical Almanack* on its useful career; the instrumental improvements and exact observations of Pond; and last, but not least, the laborious

reductions of all the Greenwich observations for nearly 100 years by the present Astronomer Royal, Mr. Airy, who has himself compiled some excellent star catalogues, who has planned instruments combining engineering and optical science in a way previously unknown, who has introduced the galvanic system for registering observations, and devised an instrument especially devoted to making trustworthy observations of the moon in parts of her orbit inaccessible by meridian instruments—an addition which has resulted in bringing up the tables of the moon to a pitch of excellence apparently leaving nothing to be desired.

In carrying out the determination to adhere to the improvement of the fundamental data of astronomy in preference to all other objects, the directors of our national observatory have evinced the greatest self-denial, and have been compelled to leave to other observatories or to private amateurs the brilliant pursuit of new planets and comets, the attractive subjects of double and variable stars, the glorious revelations of spectrum analysis applied to the heavenly bodies, and even the valuable aid of photography in delineating the features of the sun and moon. There is, however, one application of photography so thoroughly practical in its character that it has been gladly taken advantage of at the Greenwich Observatory, and it is of this interesting process that we now propose to offer some particulars, assisted as we have been by the materials kindly furnished by the Astronomer Royal.

The photographic operations to which we allude are the processes carried on for the continuous self-registration by photography of the indications of the magnetic and meteorological phenomena at Greenwich, which, although among the most valuable of all applications of the beautiful art-science referred to, is yet eminently unobtrusive in character, and for thousands who admire the photographic delineations of the persons they love or esteem, the exquisite scenery of our own or other lands, or the glories of architecture, sculpture, or painting, we can count but a few individuals who comprehend and appreciate the ceaseless working of the photographic records of the magnetic and meteorological instruments at the observatories of Greenwich, Kew, and Oxford; the daily portraiture of the solar spots at Kew, Cranford, and Ely; and the magnificent delineations of the lunar disc and the phenomena of a total solar eclipse, which Mr. De La Rue has produced; as well as the occasional photographic operations of a few other followers of astronomical or physical science.

In utility it is probable that not one of these valuable applications of photography will compare with this automatic registration of phenomena, so delicate in their nature and so

constantly changing, that but for this method of obtaining a perfect and unerring record most of their manifestations would be altogether lost, or if observed at all, it would be at intervals only, and accomplished by an expenditure of labour amounting to drudgery, which might have been better applied.

The science of Terrestrial Magnetism is perhaps not one of the most attractive, and those readers of the INTELLECTUAL OBSERVER who have studied it will doubtless, for the sake of others not familiar with the subject, pardon a few words of explanation as to what we desire to observe, and the instruments employed in observing, with the methods of using them, before we describe the photographic processes forming the principal object of this paper.

Everybody is aware of the directive property of the magnetic needle as used in the mariner's compass, but all may not equally be cognizant of the fact that the direction of the needle is not always and everywhere to the *true* or astronomical north, but varies very considerably from it at various places on the earth's surface; and that even when the variation is determined for any one place at any particular time, this variation is not constant, but is always changing. For instance, at London in the year 1550, upwards of 300 years ago, the needle pointed 11° 17′ E. of the true north; about 1660, rather more than 200 years ago, it had returned to its normal position, and then coincided with the astronomical meridian; after which it began to move westward, attained its greatest deviation of 24° 27′ W. in 1815, and is now slowly returning to the north, its present variation being about 20° 30′ W.

At Paris the variation has undergone nearly the same changes, but at other places, Jamaica for example, it has remained constant. At Liverpool it is almost 1° 30′ greater than at London; at Edinburgh about 2° 5′ greater; at Yarmouth and Dover about 40′ less. In Siberia and some parts of North America the variation is at present towards the east.

In addition to this steady *secular* variation, or *declination*, as it is now termed, there are other alterations of the direction of the magnet constantly progressing. One of these is diurnal, and causes the north end of the needle in our hemisphere to move eastward during the early morning hours; it will arrive at its extreme easterly elongation between 7 and 8 a.m.; it will then begin to move westward, reaching the extreme west point between 1 and 2 p.m., and then returning in an easterly direction. This variation is governed by the solar time at every place, and is clearly traceable to the sun's position, which produces another fluctuation in these diurnal changes, whereby for half the year, that is, from spring to autumn, the

amount of the diurnal variation is greater than in the winter half of the year. In southern latitudes the variation is westerly in the morning and easterly in the afternoon, but it follows the law of local time, and the annual inequality is also coincident with ours, although it is winter there; and the same law prevailing in the tropics, where the temperature varies but little, proves that, although produced by the sun's influence, it is not an effect of heat.

There are also sudden irregularities known as magnetic storms, which produce perturbations of greater or less magnitude simultaneously over the globe, and which have occasionally been found to be contemporaneous with the exhibition of brilliant auroræ on the earth, or sudden alterations of the surface of the solar disc. The labours of General Sabine have made us acquainted with the fact that these perturbations have the same periods for their maxima and minima as the number of solar spots as determined by Schwabe, both the classes of phenomena having a cycle of about ten years and a quarter, and this solar spot period also influences the whole of the magnetic elements.

We are indebted to the researches of the late Professor Gauss, of Gottingen, for the foundation of our present position in magnetic science. He, co-operating with the celebrated Humboldt about thirty-five years ago, formed an association for simultaneous observation at various continental stations, and himself devised the methods of observing and the instruments still used. He showed that the position of the needle at any time is the result of three forces acting together on the magnet, and that these three forces are the declination, the inclination, and the intensity of the force. The first of these elements is observed by the declination magnetometer, but the two last are not observed directly, but deduced from the variations of the two components, the vertical force and the horizontal force, which conjointly produce the direction of the magnet. The instruments used for this purpose are the dip or balance magnetometer, and the bifilar magnetometer.

An ordinary magnet will in most parts of the Northern Hemisphere have the marked end depressed, and as we proceed northward this depression increases, until we reach points where the needle becomes vertical. Thus, in 1831, Sir James Clarke Ross, in latitude 70° 5′ 17″ N. and longitude 96° 45′ 48″ W., found the dip to be 89° 59′, within one minute of the vertical; and as in the Southern Hemisphere the opposite end preponderates, the same observer in 1841 found an inclination of 88° 36′ in latitude 75° 22′ S. and longitude 161° 48′ E. These points are, it will be seen, by no means

coincident with the poles of the earth's axis, neither do they indicate the points of greatest intensity in the magnetic force, which is nearly three times as great in some parts of the earth as in others. The dip, like the declination, is subject to secular, annual, and diurnal variations, but our limits will not allow us to enter upon the details. It may, however, be mentioned that at London in 1720 the dip was 74° 42′, and in 1830 69° 38′. It is now about 68°, so that it continues diminishing.

In 1836, principally by the exertions of Humboldt, the British Government consented to co-operate in the formation of magnetic observatories, and accordingly established and equipped those at Toronto, St. Helena, the Cape of Good Hope, and Hobart Town. The East India Company established four more in their territories, while magnetic and meteorological departments were added to the observatories of Greenwich and Dublin, and an expedition to the Antarctic Seas was sent out under Sir J. C. Ross, to obtain corresponding observations in high southern latitudes. Some of these observatories were kept up for a limited period only, but others remain in full operation; and to the accumulated mass of observations thus procured, as reduced and discussed by General Sabine, we are now indebted for an immense increase of our knowledge of terrestrial magnetism and its laws.

The present Astronomer Royal has always taken a deep interest in magnetism, and is himself one of our best authorities on the subject, and in the year 1837 he became anxious that our national observatory should take part in the efforts then making to improve the science. Accordingly, at his request, an additional piece of ground was enclosed in the observatory domains, and in the following year the magnetic observatory erected. It is built of wood, and fastened with wooden pins, the metal iron being carefully excluded, except in the case of a portion of a stove and those parts of the clocks and instruments where it is absolutely necessary. The position of the building is about 170 feet from any other part of the observatory, and 34 feet from the nearest shed or erection of any kind. It is in the form of a cross, originally 40 feet in each direction, by 12 feet wide and 10 feet high; but the northern arm of the cross has lately been lengthened 8 feet. From the exterior of the observatory grounds the building is easily recognized, as in front is placed the tall mast used to collect atmospheric electricity, and conduct it to the various pieces of apparatus placed in the window of the northern arm of the building. The remainder of this arm forms the computing room of this department of the observatory. The instruments were placed in the remaining three arms of the

observatory, and, as to the magnetic department, are three in number. We say "were placed," for recently a change has been made in their positions, to be referred to presently; but it will be more convenient to describe the arrangements as they existed for many years previously. It has already been stated that the inclination or direction of a magnetized bar can be resolved into two forces acting in different directions, and the instruments used are designed to ascertain the variations from time to time, first in the direction of a needle, free to move in azimuth (that is, E. or W. with regard to the meridian); secondly, the variations in the dip or vertical plane; and thirdly, in the intensity of its horizontal force. The declination magnetometer is used for the first purpose, viz., to measure the variation, or, as it is now termed, the declination of the magnet, and the incessant alterations which are going on in this element. The instrument is placed in the southern arm of the cross-shaped building, and consists of a massive bar magnet two feet long, carried by a stirrup suspended by silken threads with as little torsion as possible, and surrounded by double gilt boxes, having holes covered with glass for the observations, to avoid currents of air, and an oval copper bar or damper to lessen the vibration. At one end of the magnet is a frame carrying a cross of cobwebs, and at the other end a lens, which renders the rays from the cross parallel. In the centre of the room is a transit theodolite, by means of which, directed to the stars through a shutter in the roof, the true meridian can be ascertained, and the readings of the direction in which the cross on the magnet is seen through the lens, as compared with the readings of the circle given by stars on the meridian, will give the amount of the declination at the times of observation. The cross is lighted either by a reflector in daylight or a lamp at night, as may be necessary for the purpose.

The dip or balance magnetometer occupied the western arm of the cross building, and, as its name implies, measures the angle formed by a magnet freely suspended on knife edges, and at liberty to move in a vertical direction. The dip, like the other magnetic elements, is in a state of constant change, some of its more important alterations having already been noticed.

In all ordinary suspended magnets, the dip is counteracted by an increased weight at the other end, and in the balance magnetometer, which is placed nearly at right angles to the magnetic meridian, this inclination is almost counterpoised, the object being not so much to determine the absolute dip, which is done by separate instruments at stated times, as the variation in the vertical force. In order to measure this

change, which requires much more delicate means than the variations of the declination magnetometer, a small plane-mirror is attached a little out of the centre of the bar, which reflects the divisions of a vertical scale attached to the wall of the room, and these reflected divisions are observed with a telescope fixed near the theodolite, the motion of the magnet having been thus much magnified.

The absolute force of the magnet at Greenwich, like the absolute dip, is determined periodically by separate experiments; but the remaining element, or the horizontal force of the magnet, is measured by the third instrument contained in the eastern arm of the room, and called the bifilar magnetometer. It consists of a magnetized bar, like the other instruments, which is suspended by two parallel sets of silk threads. If the strings and the magnet were in the same vertical plane the whole system would remain at rest; but the force of torsion is ingeniously brought into play to measure the horizontal force of the magnet. For this purpose the suspending skeins of silk pass under two pulleys, attached to a plate turning on a graduated circle with much friction, by moving which the magnet suspended to the circle is twisted out of the meridian to a position nearly at right angles with it. The force of torsion is, therefore, now acting antagonistically to that of the magnet, which endeavours to regain its normal bearing; and as the torsion force is constant, and that of the magnet subject to ceaseless variations, the magnet is always taking up fresh positions, and these angular changes can be connected mathematically with the forces producing them, and the share of the magnetic force in them deduced by calculation. The bar carries a small mirror, as in the last-described instrument, by which the reflection of a fixed horizontal scale is observed in another telescope precisely as with the balance magnetometer.

In the original arrangements of the observatory, all these instruments were observed every two hours, and on certain days in the year at every hour, and even more frequently still, which, in addition to other work of the department, fully employed Mr. Glaisher and several assistants, and was monotonous and wearisome in the extreme, as, unlike the astronomical assistants, bad weather brought them no relief of their labours. Even assuming that the observations were punctually made, it is obvious that many most important phenomena might escape notice during the two hours' interval, especially in the case of magnetic storms, and some system of continuous and automatic registration became a great desideratum. It was obvious that no mechanical arrangement, such as the movement of pencils by the magnets, was admissible;

for the finest cobweb would have effectually fettered the delicate motions of these instruments, and therefore photography was at once looked to for the required assistance, and to the inventive talents of Charles Brooke, Esq., F.R.S., the eminent surgeon and microscopist, we are indebted for the plan adopted about the year 1846, and which has since been in constant operation for the registration of the magnetic instruments we have described, as well as the barometer and thermometers.

The photographic process employed is a paper one, being a modification of the calotype, in which an invisible trace, produced by the action of light, is subsequently developed by suitable re-agents, and, waiving for the present all details of its preparation, we will first consider the mechanical arrangements of the apparatus. The sheets of paper, when properly sensitized, are wrapped round glass cylinders, which are, in fact, the ordinary glass shades used to protect works of art. Those used are 11½ inches long and 14½ inches round. Each shade is cemented into a brass cap, having a spindle projecting from the centre. This pin and the hemispherical end of the cylinder rest on friction rollers in the case of a horizontal cylinder, and a wire from the spindle, bent into the form of a winch, rests in a hole in the hour-hand of a strong time-piece, by which it is made to rotate smoothly in twenty-four hours. In the case of a vertical cylinder the time-piece is placed below the glass shade, the arrangement for rotating it on its axis being the same.

After the prepared paper is rolled round the cylinder, it is covered by another shade slightly larger, and the two are made to fit by wet tape round the mouth, and some damp wadding is also placed in the spherical end of the shade to keep the paper moist. The registration of the magnets is effected by allowing a beam of light from a very narrow slit in the copper chimney of a gas-flame placed a little out of the line joining the magnet and the revolving cylinder, to fall on a concave mirror carried by a part of the apparatus, suspending the magnet, and, of course, moving with it. This causes the beam of light to converge nearly on the centre of the cylinder about twelve feet off, where it falls upon a plano-convex cylindrical glass lens, having its axis parallel with the axis of the cylinder, by which the image of the slit is reduced to a neat spot or pencil of light. The magnet moving in azimuth, produces a spot of strong light, which runs along this lens, and, as the paper revolves under it, this light, by its actinic power, produces a continuous line round the cylinder, deviating to the right or left, and thus indicating the horizontal motions of the magnet.

A diagram of the apparatus will render this more intelligible. In the accompanying drawing (Fig. 1) only the

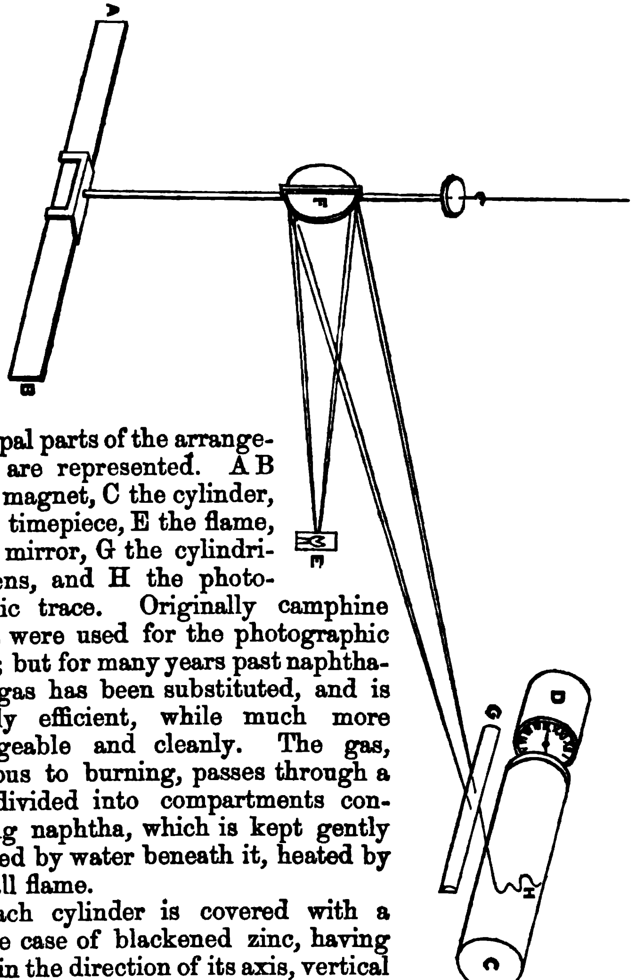


Fig. 1.

principal parts of the arrangement are represented. A B is the magnet, C the cylinder, D the timepiece, E the flame, F the mirror, G the cylindrical lens, and H the photographic trace. Originally camphine lamps were used for the photographic light; but for many years past naphthalized gas has been substituted, and is equally efficient, while much more manageable and cleanly. The gas, previous to burning, passes through a box divided into compartments containing naphtha, which is kept gently warmed by water beneath it, heated by a small flame.

Each cylinder is covered with a double case of blackened zinc, having a slit in the direction of its axis, vertical or horizontal, as the case may be, in front of which is placed the cylindrical lens. The whole course of each beam of light, from the flame to the magnets, and thence to the cylinders, is also enclosed in tubes of blackened zinc, keeping out all extraneous light.

As neither the glass cylinders can be expected to be very perfect in shape, nor to rotate very symmetrically, nor the paper to be always exactly alike in size, the following contrivance to obtain a base line from which to measure the departure of the

curve is used. A separate gas flame is placed, so that its light, reflected by a prism through a small cylindrical lens on the top of the horizontal cylinder, forms another spot of light on it, which remains stationary; and as the paper travels this prints a strong line round the cylinder, which, when the paper is unrolled, becomes the base from which the distance of the curve can be measured, and its value estimated, as next to be described.

In order to read off the indications thus obtained, and translate the photographic curve into ordinary language, observations are made with the theodolite in the old way, four times a day, and these give the value of the indications of the curve at those particular times, from which the value of other distances of the trace from the base line can readily be measured by means of a scale drawn upon pasteboard. The length of the paper being not always alike, and the going of the clock likewise slightly irregular, it is necessary to have a time scale as well, instead of simply dividing the paper into hourly parts. This is effected by shutting off the light occasionally for a few minutes from the cylinder, which, of course, leaves a white spot in the curve, and the interval between two such operations being accurately noted, gives the time equal to a certain length of paper, and to divide this readily an ingenious expedient is adopted. A slip of vulcanized India-rubber is stretched in a brass frame, which, by a screw, will lengthen or contract the slip, and the scale being marked on the India-rubber, it can be altered so as to make its divisions correspond with the value of the period of time measured by two breaks in the curve on the paper.

With respect to the absolute length of the photographic traces, it may be mentioned that a variation of 1° in the declination magnet is measured by five inches on the cylinder, and that a variation of 1000th part of the horizontal force covers about $\frac{1}{4}$ of an inch on the paper, and the same variation in the vertical force about $\frac{1}{2}$ an inch.

The same cylinder is made to record the indications of two instruments, by being so placed that the light from each falls on different sides of it, the base-line being made between them. The declination magnetometer and horizontal-force magnetometer record their variations on one horizontal cylinder, and the vertical-force magnetometer on a vertical cylinder, which also receives the trace of the barometer obtained in the following manner:—

The instrument is a large bore one of the syphon form, having the lower surface of the mercury more than one inch in diameter. This surface supports a glass float, from which rises a vertical rod. This rod presses at right angles against a long

and light lever, the greater part of the weight of which and of the float is counterpoised, leaving a small residue only pressing on the mercury. The barometer is about thirty inches from the cylinder, and the fulcrum of the lever is still further off. The lever carries a plate of opaque mica in front of the rotating vertical cylinder, having a small hole in it, through which the photographic light of a gas jet, concentrated by a cylindrical lens, passes, and records the rise and fall of the barometer, which, by the action of the lever, is multiplied four times in length, rendering the indications easily read off. An independent pencil of light, shining through a fixed aperture, traces a base line, from which the heights are measured, a few

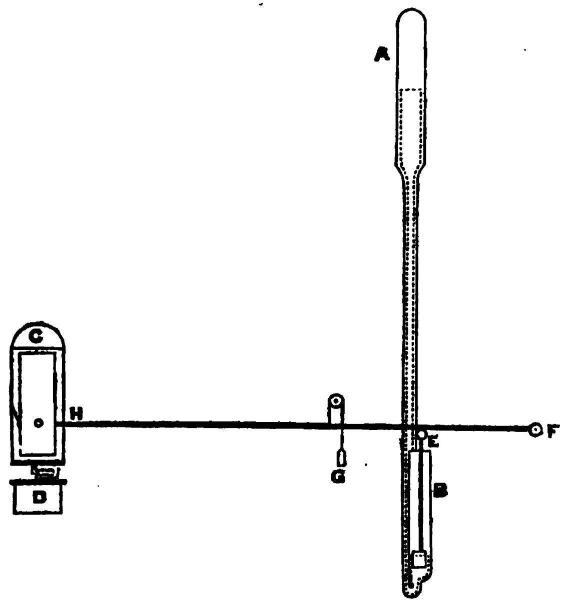


Fig. 2.

eye observations being made every day to obtain fundamental points.

The annexed diagram (Fig. 2) shows this apparatus in detail. A B is the barometer, C the cylinder, D the time-piece, E the vertical rod, F the fulcrum, G the counterpoise, H the lever and mica plate.

Another vertical cylinder, placed under a shed in the grounds of the observatory, photographically records the readings of dry and wet bulb thermometers by a very simple arrangement.

The thermometers are mercurial, and have large bores nearly half an inch in diameter. Fine wires are placed at every degree across a plate which covers the tube, and has a slit in front of the mercury column, with thicker wires at every 10°, and extra ones at 32°, 52°, and 72°.

The light of a jet of naphthalized gas is condensed by a cylindrical lens upon the thermometer tube, and as the mercury rises or falls, it obscures or uncovers the sensitive paper, and leaves a broad photographic trace on each sheet, which shows the height of the thermometer, and the exact degree can be ascertained from the numbers indicated by the spaces of light produced by the intercepting wires. This cylinder is larger than the others, being 13½ inches long and 19 inches in circumference; it rotates once in 48 hours, and requires no base-line.

The preparation of the sensitive paper is a point of great interest, and after many comparisons with other processes, the following one, which has been very little altered from the commencement of the photographic registration, is still adhered to. It was a matter of considerable difficulty to devise a system which, while the paper should be so sensitive as to be affected by artificial light, should also retain this quality for onė or two days, and then allow the hitherto invisible trace to be developed with an equal amount of intensity. We give the process in Mr. Glaisher's own words, slightly abridged:—

"The paper is made by Hollingworth, and is a strong one, of even texture.

"*First Operation.*—Preliminary preparation of the paper.

"1. Sixteen grains of iodide of potassium are dissolved in one ounce of distilled water.

"2. Twenty-four grains of bromide of potassium are dissolved in one ounce of distilled water.

"3. When the crystals are dissolved, the two solutions are mixed together, forming the iodizing solution. The mixture will keep any length of time.

"Immediately before use, it is filtered through filtering paper.

"A quantity of paper, sufficient for the consumption of several weeks, is treated in the following manner, sheet after sheet:—

"The sheet of paper is pinned on a board, and a sufficient quantity (about fifty minims for a sheet of paper fifteen inches long and nine and a-half inches broad) of the iodized solution is applied by pouring it upon the paper in front of a glass rod, which is then moved to and fro till the whole surface is uniformly wetted by the solution.

"The paper thus prepared is allowed to remain in a

horizontal position for a few minutes,, and is then hung up to dry in the air; when dry, it is placed in a drawer till used.

"*Second Operation.*—Rendering the paper sensitive to the action of light.

"A solution of nitrate of silver is prepared by dissolving fifty grains of crystallized nitrate of silver in one ounce of distilled water, adding in hot weather a few drops of acetic acid.

"Then the following operation is performed in a room illuminated by yellow light:—

"The paper is pinned as before upon a board, and (by means of a glass rod as before) its surface is wetted by fifty minims of the solution. It is allowed to remain a short time in a horizontal position, and if any part of the solution remains unabsorbed, the superfluous fluid is taken off by the application of blotting-paper.

The paper, still damp, is immediately placed upon the interior glass cylinder, and is covered by the exterior glass cylinder, and is mounted upon the rotating apparatus to receive the spot of light formed by the mirror which is carried by the magnet.

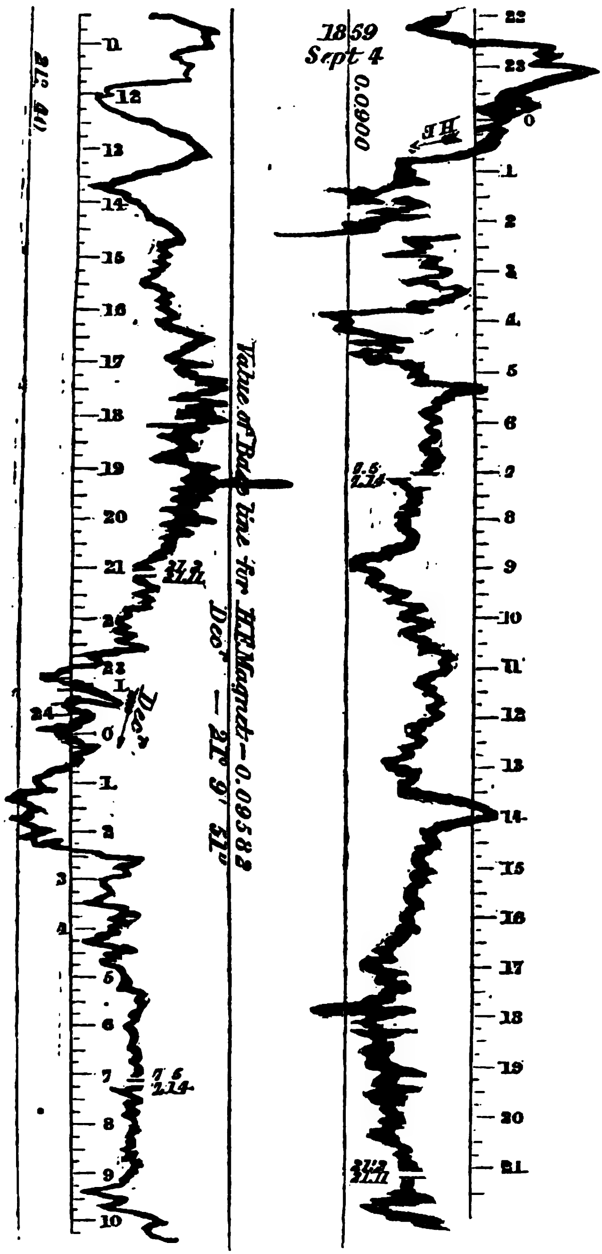
"*Third Operation.*—Development of the photographic trace.

"When the paper is removed from the cylinder it is placed upon a board, and a saturated solution of gallic acid, to which a few drops of acetic nitrate of silver are added (in hot weather this solution is used at the temperature of the air, in cold weather it is heated to the temperature of seventy or eighty degrees), is spread over the paper by means of a glass rod, and this action is continued until the trace is fully developed. When the case is well developed the paper is placed in a vessel of water, and repeatedly washed with several successive supplies of water, a brush being passed lightly over both sides of the paper to remove any crystalline deposit.

"*Fourth Operation.*—Fixing the photographic trace.

"The photograph is placed in a solution of hyposulphite of soda, made by dissolving four or five ounces of the hyposulphite in a pint of water. It is plunged completely in the liquid, and allowed to remain from one to two hours, until the yellow tint of the iodide is removed. After this the sheet is washed repeatedly with water, allowed to remain twenty-four hours in water, and afterwards placed within the fold of linen cloths till nearly dry. Finally, it is placed between sheets of blotting-paper, and a heated iron passed over it."

From the original records thus obtained, after they have had placed upon them with pen and ink the necessary data of the times of the breaks in the curve to obtain the time scale,



FAC-SIMILE OF PHOTOGRAPHIC TRACE OF 4TH SEPTEMBER, 1859.

the value of the base line, the epoch of the sheet, and other data, negatives are prepared in the ordinary way of photographic printing, from which secondary photograms positive tertiaries can be printed, which are faithful copies of the original sheets that were placed round the cylinders, and such copies are distributed when necessary. The paper used for the printing process is made by Rive, and the salting solution is chloride of ammonium, and the sensitizing one ammonia-nitrate of silver. Having by the kindness of Mr. Airy, the Astronomer Royal (who has supplied every information necessary for this article), been furnished with a duplicate of one of the photographic records, and permission to use it in any way thought desirable, we are enabled to offer our readers a reduced *fac-simile* of the trace on the horizontal cylinder which records the variations of the declination and bifilar magnetometers. The date is 4th September, 1859,* and the wood engraving, although unable to give the full effect of the photographic curve as to its minute inflections and transparency, is most curious and interesting, and, we believe, the first opportunity most of our readers have had of inspecting these beautiful tracings by the pencil of light, of the occult workings of one of the most important, and at present obscure, physical forces.

We have hitherto spoken of the instruments as placed upon the ground level of the observatory, which position they occupied from its establishment until last year, when in consequence of the difficulty of keeping the temperature nearly constant (and unless this be effected the variations are influenced by it) an excavation was made under the building to the extent of the three arms of the cross occupied by the magnets, and this being well bricked round, the instruments have been placed in these vaults, which are lighted by sunken windows of yellow glass; and as the temperature now rarely varies more than 10° from 60°, the indications which have been obtained this year when the observations were recommenced after the necessary interruption, are considered better than the former results. The original declination magnetometer, however, remains above in the southern arm of the cross building, for the sake of still observing the transit of circumpolar stars through the roof-slit, to obtain the astronomical meridian, and read off the departure of the magnet from the true north. An exact duplicate being mounted below the observations made by the theodolite above and the photographic ones in the apartment below are strictly comparable.

* The curve displays some very considerable perturbations, and it may be remarked that on 1st September, 1859, Mr. Carrington and Mr. Hodgson witnessed the violent outburst of light on a solar spot, which affected magnetic instruments simultaneously in all parts of the globe.

The saving of labour resulting from the introduction of the automatic registration of the instruments is most considerable, involving the release of two assistants at least, and an entire absence of night work. The observations are also more exact, and being continuous instead of intermitting, is, in the case of instruments whose changes are so incessant and capricious in their nature, an advantage that cannot be estimated too highly.

The system thus inaugurated at Greenwich has been adopted at the observatory of the British Association at Kew, and will no doubt be used in the cases where instruments are supplied from that establishment; and at Oxford the meteorological observations are registered in a similar manner.

It only remains to mention that, during the last few months, an interesting addition has been made to the photographic recording apparatus at Greenwich. In order to detect electrical currents in the earth, two wires are stretched, the one to Dartford and the other to Croydon, passing into the earth at both ends, and having galvanometers included in the circuits; but no batteries are employed. Each magnet has a mirror mounted, by which a spot of light is reflected to a photographic sheet, mounted on a cylinder made of ebonite, and the curves are thus registered as in the other cases. The apparatus has only been mounted about two months, and it is too soon to infer anything from the results; but it may be mentioned that the Dartford current, running E. and W., is stronger than the Croydon, which runs from N. to S.; that both are stronger than was expected; and that the trace of the Dartford current occasionally bears a strong resemblance to that of the declination magnetometer. Such indications cannot fail, when observed sufficiently long and properly discussed, to throw light upon the causes of terrestrial magnetism, and add another to the benefits resulting from the operations of Greenwich Observatory.

LUNAR DETAILS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

In our last paper we did not quite terminate the subject of *Proclus* (12). This crater is the origin of several luminous streaks, which, however, are well seen only under favourable circumstances. Two take the direction of the *Mare Crisium*, and may be traced as far as its centre. Schröter, on one occasion, 24h. after Full, when the W. edge of the plain lay on the terminator, perceived three crossing nearly its whole extent. This grey level should be watched with reference to variations of this kind. From more than one source I have been favoured with observations proving that something similar to the appearances described in Int. Obs., v. 203, may occasionally be perceived.* A collection of radiating streaks also issues from *Proclus* towards the N.E. In this direction a very sharp and nearly straight line connects *Proclus* with a small crater, *Proclus d*. This line marks the course of a slight declivity, at the foot of which lies the—

Palus Somnii, a remarkably well-bounded and always distinguishable region, E. of *Proclus*, having a form somewhat resembling an irregular rhombus, or heraldic "lozenge." B. and M. observe that its colour is quite peculiar, but difficult to be designated; something of a yellowish brown. It is altogether occupied by hills of no great elevation, chiefly following a meridian direction; and its aspect is singular, unlike that of the other regions which Riccioli comprises under the general term *Paludes*, but probably much resembling many regions of our own globe. The region S. of *Proclus* is of a somewhat similar character: the shortness of the shadows here thrown towards the *Mare Tranquillitatis* (D) and the *M. Fœcunditatis* (P), as compared with those falling in the direction of the *M. Crisium* (A), indicate the considerably deeper level of the latter surface.

The *Mare Tranquillitatis* (D) gives rise to a remark by B. and M., that from a merely superficial glance at the lunar disc, it might appear as though its seas were diverse only in form and magnitude; but a more careful comparison under various incidences of light will bring out so many peculiarities in each of them, as alone to prove, even if no other grounds for the contrary belief existed, the insufficiency of the assumption of a general covering with water or any other homogeneous fluid. This extensive plain is divided from the *M. Serenitatis* on the N.E. in a singular way, by a very straight and continuous slope of

* See Mr. Slack's observation, Int. Obs. vii. 322.

trifling breadth, but, according to Schröter, more than ninety miles in length, proving that the latter plain, in this region at least, must lie at a lower level: its remaining boundaries are more distinctly made out by its hue than by any strong, natural configuration of mountain or cliff. Its colour is a clear grey, without any trace of green or other distinguishable hue. The surface is diversified and "marbled" by a multitude of very minute streaks of light, perceptible only under the most favourable circumstances. It is intersected by a number of long, low banks, many of which unite themselves in a broad central mass of slight elevation. To this plain belongs the conspicuous crater *Plinius* (13), a cavity thirty-two* miles in diameter, with an interior full of small inequalities, a ring built up in terraces, and a luminous central hill; the whole forming a very confused, though brilliant mass in the Full Moon. The wall, which is much blocked up by its exterior adjuncts, is, according to Schröter, more than nine miles broad, nearly 1400 feet above the neighbouring region, and 7300 feet above the interior (1000 feet more than is given by B. and M.). On two occasions, with two different instruments, and with an interval of more than twenty-five years, I have seen the two summits of the central hill figured by B. and M. as minute craters. Such illusions may easily take place when the shadows of small eminences fall among other elevations of a similar character, and show the necessity of caution in forming conclusions under these circumstances. *Plinius* A, a crater of fourteen miles in diameter, just to the W. of *Plinius*, is remarkable as the centre of a large white area, considerably brighter than the surrounding level. Its W. side has 8° of brightness, the E. wall is 2200 feet above the outer plain, and the depth, according to Schröter, is at least 5700 feet.

S. of *Plinius*, in the region between it and the equator, lie three pairs of craters near the E. edge of the plain:—*Ross*, 4100 feet deep according to Schröter, and *Ross* A—*Arago* and the much smaller *Arago* A—and *Ritter* and *Sabine*: the four first remarkable, as well as other craters in the district, for the corresponding position in each case of a "wall-peak" or tower on the S. edge of the ring; the two last as forming a double ring of which the components are nearly similar. The W. wall of *Ritter* (the more easterly and higher of the two) is 4000 feet above the interior. Nearly W. of this last pair,

* Schröter gives twenty-five miles; L. thirty-five. The discrepancy may in this case probably be ascribed to the circumstance that the ring is of an oval form. But, generally speaking, those who are accustomed to lunar observations will feel no great surprise at variations of this kind, which may naturally occur when the wall is of a terraced construction, without any very dominant crest, and the shadow may consequently be cast from different ridges under different angles of illumination.

across a wide extent of grey level, lies *Maskelyne* (14), a crater about 18 miles across, 4500 feet deep from the E. side of its irregular ring, and 3000 from the outer level. L. assigns to it a central hill, neither figured nor described by B. and M. Less than half way from this crater to *Taruntius* (91), we find a considerable grey ring in the plain, and a little N. of it another somewhat smaller, whose E. sides, about 300 feet high, are lost to sight 16h. after the terminator has past them, so that the opposite portions alone remain visible, like isolated curved hills, as in fact they are figured by L.—B. and M. observe that "many lunations may pass without even the most attentive observer's perceiving anything of them; this evening they are *not yet*, to-morrow morning they are, perhaps, *no longer* to be seen." The preceding details have been introduced for the sake of this valuable remark, whose application is of a more extended nature.

Mount Hæmus.—By this name, introduced by themselves, our authorities designate the S. boundary of the *M. Serenitatis* (E), from the neighbourhood of *Plinius* (13), to *Menelaus* (15), and about as much further again, to a small luminous crater, *Sulpicius Gallus.* No region, they observe, excepting that adjoining *Vitruvius*, exhibits within so small an area so many contrasts of "light-tone," visible even on the dark side of the moon, and producing a charming effect in the eclipse of December 26, 1833, when even the minutest objects were perfectly distinguishable. Some parts of the range attain 8° or 9° of reflective power in the Full Moon, and a multitude of bright specks lie scattered about the vicinity. In proceeding eastward from *Plinius*, we pass a beautiful chain of "islands," the highest not attaining 800 feet, before reaching the *Promontorium Acherusia.** The headland so called rises to 4800 feet, with an aspect which may, as B. and M. remark, resemble "Cornwallis and Alaksa" (Cornwall and Alaska ?), seen from the moon. The mountains rise and spread, forming the coasts of two different *seas*, the *M. Tranquillitatis* and *Serenitatis*. Following the shore of the latter, we soon reach—

Menelaus (15), a fine crater; according to Schr. 16m. broad: L. makes it 21m. B. and M. have given no measure. They describe it as having a broad ring, the interior of which reflects the light at different times from one or the other side, almost like a concave mirror, whence its great brightness of 8° and 9°. Its steepness conveys at first the impression of a greater depth than it possesses; it is actually, however, very con-

* Spelt *Archerusia* by Hevel and Schr., and in the great map. The text, however, seems to be right. It is the ancient name of a headland in Bithynia, near *Byzantium*, the appellation given by Hevel to the crater now called *Menelaus*.

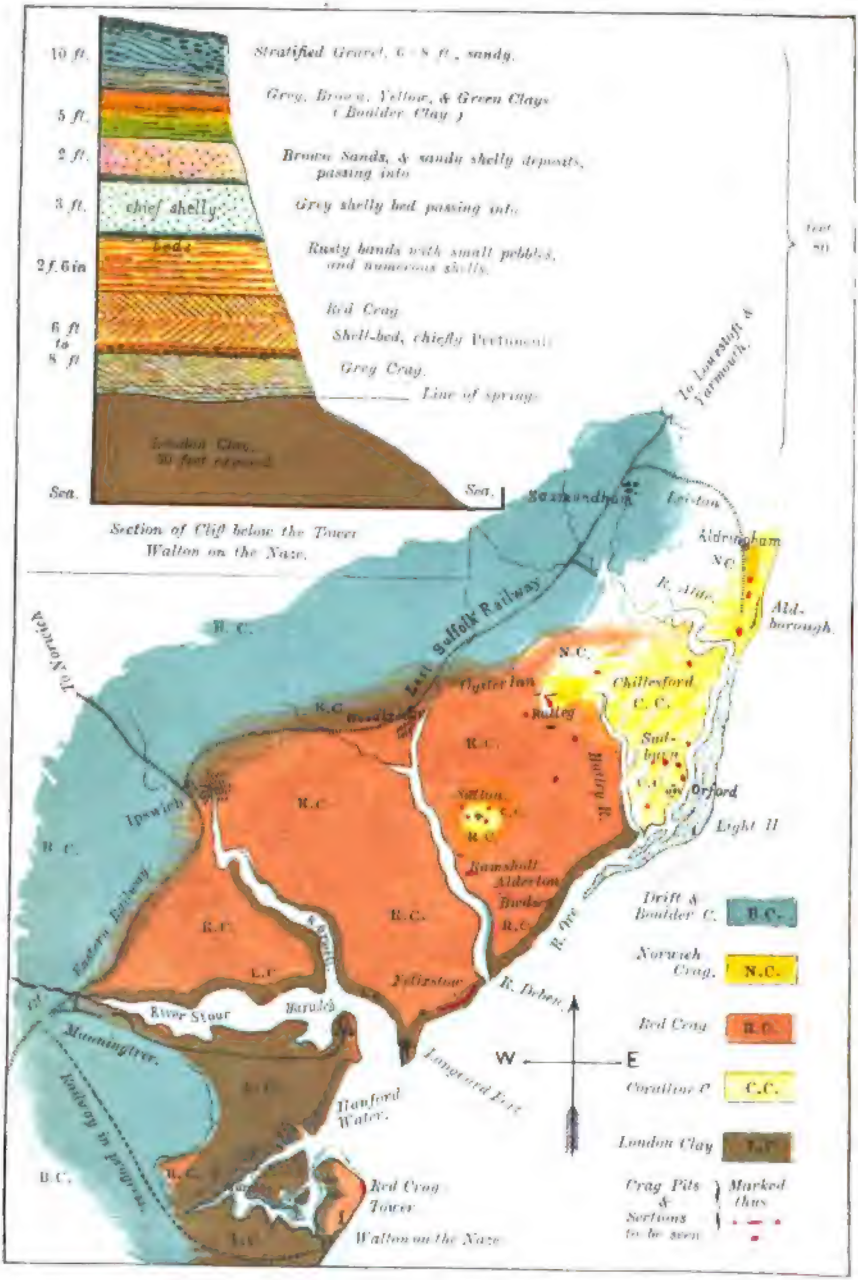
siderable. B. and M. measured it at about 6600 feet; and 5500 feet under a doubled angle of illumination, when the end of the shadow would fall in a less depressed part. Schr.'s two measures gave about 8000 and 7500 feet. The smaller crater, *Menelaus b*, lying just S.W. of the larger one, has, according to Schr., a depth of 4570 feet—greater in proportion to its diameter, as he always observed with regard to the lesser cavities.

From one of the "Phases" (No. 9) of Hevel's ancient *Selenographia*, it would appear that some mountains in this vicinity must be of extraordinary height. He makes their projection into the night side, even in a necessarily somewhat foreshortened position, with a W. long. of 16°, $= \frac{1}{26}$ of the moon's diameter, or as great, at least, as that of any lunar elevation. Schr. is mistaken in ascribing this supposed height to the W. end of the *Prom. Archerusia*, as it is evident, both from Hevel's figure and description, that he refers it to the other end of the promontory, in the immediate neighbourhood of *Menelaus*. The assertion is not borne out, and seems not to have been thought worthy of remark, by later selenographers; yet Hevel was so careful in his way that it might be as well to examine whether any shaded depression, where the terminator crosses the *M. Serenitatis*, may cause an illusory effect of projection.

B. and M. here call attention to a very curious fact, that all the mountain ridges proceeding from *Menelaus* run in a S.W. direction, and that this parallelism extends not only through all these high lands, but prevails also almost exclusively through the greater part of the *Apennines* (23), and all the mountainous regions lying to the S., as far as the craters *Pallas* and *Bode* (28), and to the other side of the equator, flattening even the circular forms of the craters in its way. They further observe that since what we call W. on the moon (*i.e.* turned to our W.) would appear E. to an eye transported there (an apparent reversal of bearing taking place in looking at the moon, just as when we stand face to face with another person, whose right hand is opposite our left), therefore this S.W. direction of lunar parallelism corresponds in reality with that from S.E. to N.W. so prevalent on the terrestrial globe.

Menelaus is the starting point of several luminous streaks, which for the most part belong to the *M. Serenitatis*, except one which runs to the S.E. Occasionally, B. and M. say, this streak, a strong one in the *M. Serenitatis*, and some others lying N. and S. in the same direction, appear to be only portions of one great ray reaching from *Tycho* to *Thales*, through upwards of 1800 miles. This is more evident with low powers, which, however, are apt to give apparent unity where higher ones show distinction.

The E. portion of *M. Hæmus*, which runs off into the *M. Vaporum*, attains a less elevation than the other end, and can scarcely be termed mountainous. In concluding their description of this region, B. and M. remark the striking and unmistakeable contrasts of reflective power that are here crowded into a small space, and are many of them independent of the relief of the surface. In general the mountains are bright, and the valleys dark. Yet, under an oblique illumination, it is obvious how slight or imperceptible a difference of level is frequently combined with great inequality of light, while in other far more uneven regions, such as those lying N. of the *M. Serenitatis*, and the *Carpathian Mts.*, not to mention the S.W. Quadrant, an uniform degree of brightness prevails. Is this, they inquire, to be ascribed to some peculiar cause in the original formation of the moon, or to some persistent reason? This district seems to them highly worthy of a more careful and less fragmentary investigation than it has yet received; they content themselves, however, with remarking that they have repeatedly thought that the separate portions of the surface nowhere show a clear and decided "light-tone," but rather an almost inextricable mixture, as though from a mechanical union of specks of light and darkness. It does not seem very likely that a larger instrument than that used by B. and M. (which had barely 4½ inches of aperture) would be of any great service in unravelling these mysteries, since the superfluous amount of light in the brighter portions would produce a dazzling, rather than a discriminating effect. But with the addition of a lightly-tinted screen-glass, great apertures might prove very efficient; though an objection may possibly lie against the employment of a coloured medium in very delicate observations, from the partial absorption it must exercise on light, the composition of which is uncertain: in this point of view an interesting experiment might be tried, by the successive introduction of a number of differently tinted screens of equal depth, the result of which might possibly be the detection of colours in the moon, too delicate to be otherwise recognized. But—excepting for such an investigation—it is probable that the employment of an unsilvered glass speculum might produce the most satisfactory result. On this subject the reader may be referred to Dr. Draper's experience, recorded in our last number; and there seems reason to believe that an instrument of this kind, ensuring the defining power which is the result of large apertures, without either an overpowering glare of light, or any objectionable mode of lessening it, might be found of especial value in lunar observation.



Map of the CRAG DISTRICT.

COLOURS OF STARS.

In the last number of the INTELLECTUAL OBSERVER were some remarks on the desirableness of noting on an extensive scale the existing colours of stars, in the hope of obtaining more extensive and decisive evidence as to their presumed variability. The following instance will tend to show that a little attention bestowed in this direction might be well repaid.

1865. June 22. Happening to be looking at the beautiful group, o^2 Cygni (No. 58 of our list), without at the time knowing the object, I noted the colours (the letters indicating the magnitudes), A orange yellow, C sapphire blue, B white, or very pale yellow, with a sort of cast of blue in it, but certainly not at all like C. The latter star I found kept its colour when A was out of the field. I subsequently found what I had been looking at, and that each of the smaller stars had been recorded by Struve "cœrulea," 1835·95, and by Sm. "cerulean blue," 1838·67, with the addition that at Dorpat the two smaller stars preserved their blue colour when the larger star was hidden. On the contrary, I found that in an old observation of my own, 1850·77, with $3\frac{7}{10}$ inches of aperture, I made B white, C blue; there being no difference among the observers as to the colour of A. I have subsequently received from more than one quarter a full confirmation of my belief that the two stars are now no longer of the same colour; and the change, as it appears, must have taken place in the period intervening between 1838 and 1850. Without laying too much stress upon this case, we may at least admit that it furnishes an appropriate stimulus to further inquiry.

AN EXCURSION TO THE CRAG DISTRICT.

BY HENRY WOODWARD, F.G.S., F.Z.S.,

OF THE BRITISH MUSEUM.

(*With a Coloured Map.*)

THERE are numerous localities in our island but seldom explored, where the holiday-maker and amateur geologist may collect for himself, and in so doing learn far more about rocks and fossils than he can ever do from books alone. With this view I propose to give some account of an excursion made along a portion of the eastern coast, in company with my friend Mr. Bakewell, for the purpose of seeing the Suffolk Crag, and collecting Crag-shells.

We started by the "Metis" steamboat from London Bridge Wharf, at 10 a.m., to "Walton le Soken," alias "Walton on the Naze," a quiet little out-of-the-way sea-side village in Essex, at which we arrived at two o'clock p.m.

The run by the "Metis" and "Father Thames" steamers between London and Ipswich, passing down the Thames and up the river Orwell, forms a short and most delightful summer's-day voyage, and those who can resist the *maladie du mer* will be well repaid by the pretty rural scenery of the Orwell at high tide, which on either bank is wooded, often to the water's edge. The sea trip must be enjoyed for the sea itself, as nothing will be visible of the land between Shoeburyness and Walton, for you will notice by the map that the low flat coast of Essex retires up towards Colchester, leaving a large area of shallow water outside, which the steamboats keep, and the land being very low, is nearly, if not wholly out of sight.

The aspect of the Essex coast, composed of denuded Secondary and Tertiary strata,* contrasts very strongly with the corresponding western shore, where the eldest rocks of our island make up, by their vast thickness and repeated crumplings, the ancient Welsh mountains, snow-capped for more than half the year.

If unvisited by the summer steamboats, Walton would be nearly as isolated from the rest of the world as the Channel Islands. The "Naze," or neck of land on which the village stands (see Map) has the sea on the east, north, and west, and is approached from the south only by a single road. It is eighteen miles from Colchester,† and although within seven miles of Harwich in a direct line, it is fourteen or fifteen by the nearest foot-ways round the salt marshes.

A little to the north and south of the village the cliffs rise from forty to eighty feet for a short distance, sloping down inland to the salt marshes in the rear. It is that portion of the cliff about a mile to the north of the village where the nearest Crag "out-crop"‡ occurs. The spot is well marked by a lofty hexagonal tower, eighty feet high (erected by the Trinity House Board as a landmark and signal-tower for ships). The tower itself stands in the middle of a field between the road leading to Walton Hall and the cliff. Just below this, in the face of the cliff, the Crag may be seen (see Section). It is easily distinguished from the London clay by

* Chalk and London clay, with patches of Crag and Boulder-clay.

† A branch railway is about to be opened to the little town.

‡ The section given in the coloured plate is taken at this spot, and the measurements and details have been kindly furnished me by my friend, Robert Etheridge, Esq., F.R.S.E., F.G.S., etc., Palæontologist to the Geological Survey.

the deep red stain, due to oxide of iron, which has caused this division of the newer Tertiary to be called "The Red Crag." It overlies the London clay, which here contains traces of decomposed vegetable remains and abundance of gypsum (*selenite*) in clear crystals, but no shells or animal remains.

The village stands upon the lowest part of the Naze, and the land rises both to the north and the south.

The sea constantly encroaches here and has much reduced this little peninsula. There is a breakwater to the north of the pier made of stone, about 500 yards long, on which a terrace is built, and the Coastguard Station-house. Beyond this the only protection afforded to the cliff is by rows of piles driven in pairs into the beach in straight lines, with planks of wood placed between them. These are being rapidly destroyed near low water by the *Teredo,* and may be crushed beneath the foot.

Great masses of the blue London clay, which here forms a large proportion of the cliffs, fall from time to time with a heavy thud upon the beach, causing the passer-by to start aside and congratulate himself on his escape.

At one part of our walk along the footpath on the top of the cliff we came to the corner of an enclosure which abuts so nearly upon the edge of the precipice, that the stile (three feet wide) only remained between it and the fence. Probably by this time the footpath itself is gone.

The great agents at work in assisting the sea to undermine these cliffs are the land-springs, frosts, and thaws. Springs occur here every few yards, and where a spring is, there the cliff is most unstable.

At the point where the Crag is seen, an attempt has been made to save the cliff by cutting deep trenches, or gullies, and placing drain pipes and faggots in them to guide the water direct to the beach. A considerable quantity of Crag has thus been thrown out, and where not overgrown with weeds and grass, we found the surface covered with Crag-shells washed out by the rain; many hundreds were broken, but some still remained perfect.

I may here state that the Crag is composed almost entirely of shell-remains, interstratified with bands of sand and gravel (see Section), and containing, especially in the Coralline Crag, undisturbed reefs of Bryozoa and shell-banks, buried, and afterwards upheaved, just as they had been formed in the sea.

The Crag being very friable, it is far easier to discover perfect shells than to extract them from the loose matrix. Even when this has been accomplished, the greatest care is

needed in packing them, or you will find only shell-gravel in your box on returning home.*

We were able, on our first visit, to ascertain the best place to work the Crag, and had also procured some six or eight genera of shells, as proofs of the existence of the formation; but as it was now too dark to collect, we determined to return to the inn, where we unpacked our Crag and made a few notes thereon.

Among the characteristic fossils of the Red Crag we found the following shells:—*Fusus contrarius, F. costatus, Murex alveolatus, Buccinum Dalei, Nassa reticosa, Voluta Lamberti, Pectunculus glycimeris, Lucina borealis, Cardium Parkinsoni, C. angustatum, Mactra arcuata, Artemis lentiformis,* and a tiny sea-urchin, *Echinocyamus Suffolciensis.*

Certain of these are very abundant, and others only rarely met with entire; thus *Fusus contrarius* and *Pectunculus glycimeris*, are exceedingly common, whilst *Voluta Lamberti* and *Cardium Parkinsoni* are extremely rare, and would be highly valuable finds.

Early on the following morning we again set out for the Crag, after having first purchased a small spade. We worked away at the undisturbed Crag with our spade and long knives all day, returning to a late dinner at the inn.

Our collection was not large, but we obtained some very fair and perfect specimens, and as we hoped to do more at Sutton and Sudbourn, we decided upon marching on the morrow to Harwich.

We were up by five next morning, and after having breakfasted, mounted our knapsacks and started for Harwich. Having ascertained that we could cross Hanford Water from Stone Point to the Harwich side of the salt marshes, and so save six miles, we decided to endeavour to catch the Revenue-cutter's boat at high water, the only time a landing can be effected.

We were just in time to save the tide, and were soon crossing towards "Peewit Island." We found it a good mile across from Stone Point to the landing at the head of the creek leading to the sea-wall, along which the footpath runs. The tide was running out at a great rate, and made rowing up the narrow stream a very difficult operation. Having each taken an oar, we pushed until we were fairly aground, and then we saw, about three boat's-lengths off, the first stepping-stones leading to the longed-for footpath. This was most tormenting, as the mud was up to our waists. At length the ingenuity of

* Most of the Crag-shells, especially the bivalves, require to be strengthened by the application of repeated coatings of thin gum-water, which is absorbed readily and hardens the tissue of the shell.

our boatman got us over this dilemma. In the bottom of the "punt" he had three strips of board, and by placing these cautiously one beyond the other, and supporting each of us with an oar, he passed us one by one along this narrow gangway to *terra firma*, and so, after a muddy walk on stepping-stones, we reached the sea-wall *en route* for Harwich. There formerly existed a cliff capped with Crag here, but it has been long since washed away.* Harwich and Dovercourt cliffs are now both well protected against further encroachments of the sea by an excellent stone breakwater, two miles in length, which affords a fine walk to visitors, who come yearly in increasing numbers to enjoy this rising Spa.

We came into Harwich with good appetites, after satisfying which we crossed the Orwell in a sailing boat, and landed at Walton Ferry, intending to push on, through Felixstow and Alderton, to Ramsholt that same night if possible. We walked over some fields which terminate the county of Suffolk, upon the extreme southern point of which Landguard Fort is situated, and came once more upon the beach a mile south of Felixstow. Here the cliffs again rise up to a good height, with Crag and London clay, but we did not succeed in procuring any fossils.

At Felixstow I found a letter from my friend, Mr. Colchester, of Grundisburgh Hall, one of the largest exporters of coprolite from this county, inviting us to inspect the Crag pits on his estate at Sutton, of which we had heard such interesting accounts from Mr. Searles Wood. We were constantly reminded of our proximity to the Crag by observing the private roads gravelled with it, and we picked up several entire shells of *Litorina* and *Murex* as we walked along.

Near Bawdsey Ferry we noticed in front of the cottage-doors small heaps of the dark-brown, shining, water-worn pebbles called "coprolites," which ten years ago created an extensive trade here, and the preparation of which for artificial manure gave employment to numbers of peasantry.

The superior yield† of the coprolitic deposits of the Cambridgeshire Greensand, which give a more abundant supply

* The men employed by the Harbour Commissioners in "didling," or dredging up stones, etc., in the entrance to the Orwell and Stour rivers, off Harwich, collect vast numbers of *Septaria* (huge concretions washed out of the London clay, which are used in the manufacture of "Roman cement"), nearly every one of which contains some organic body in its centre, around which the mass seems to have formed. Those found at Harwich frequently contain the remains of fossil turtles.

† Mr. Colchester informs me that himself and another proprietor at Royston raise no less than 300 tons of this fossil manure *daily*, or about 93,300 tons per annum.

of "superphosphate," has tempted Mr. Colchester to a new and more attractive spot at Royston. The nodules of this coprolitic deposit of the Crag contain numerous organic remains, some of which, such as the crustacea, teeth of fishes, etc., appear to have been derived from the *débris* of the London clay, and some few from still earlier formations; but the larger proportion, including the mammalian teeth and bones, most probably represent the wreck of the Miocene or Middle Tertiary series, so well developed in France and Germany, but (with the exception of the Bovey-Tracey lignite and the Hempstead beds in the Isle of Wight) almost unknown on this side of the Channel. They are certainly the oldest part of the Crag formation.

We were rowed across the Deben in a small boat, and, leaving the river, walked up the hill through the village of Bawdsey to Alderton. We should have done wisely had we halted here for the night; but as Mr. Searles Wood had told us that Ramsholt Dock Inn was the place he staid at some years before when working at the Crag, we determined to put up there, as it was only two and a half miles beyond Alderton. My friend and I tried it for one night, and our advice to collectors intending to go there at night as we did is—*Don't!*

Early next morning we started out again, and five minutes' walk brought us to the river-side and the Crag, and we were soon at work poking away at the bright red-stained Crag-bank. This is the hardest Red Crag I have seen; the percentage of iron is much greater, causing it to cake firmly together, and resist disintegration. The strata are very curiously false-bedded, and there is a good illustration of unconformability between the upper and lower beds. We procured here very fine specimens of *Fusus antiquus*, *Natica millepunctata*, and *Trochus ziziphinus.*

Passing up the river side, we came to a small plantation, in which is a Crag-pit, with a bed of *Modiolæ in situ;* but the valves lie so close together, and are so brittle, that it is almost impossible to obtain an entire specimen.

Leaving the river, we ascended the hill towards Mr. Colchester's farm at Sutton. We saw the first large accumulation of "Coprolite" here, lying at the entrance to a field, probably twenty tons; we picked up a water-worn tooth of the great shark *Carcharodon*, and another of *Lamna*, but no good examples of coprolites, although some pieces showed the twisted form slightly.

On inquiring for Mr. Wood (Mr. Colchester's steward), he soon appeared, and was most obliging and attentive to us throughout. He amused us by pulling from his pocket a

handful of sharks' teeth, two fossil crabs, and a very fine corkscrew coprolite, the best specimen I ever remember to have seen. These he presented to us.

The first pit we worked at was in the Red Crag. Here we obtained many perfect shells of *Natica, Pecten, Pectunculus, Fusus,* etc. Then to a Coralline Crag-pit, where we were told Mr. Searles Wood obtained his *small* shells.

Our guide proposed to send us up a sack of this per rail, to pick over at home at our leisure. I am sorry I declined the offer, as I don't doubt but it would well repay the trouble of sifting. The minute forms of Bryozoa,* of which it seems almost entirely composed, were very beautiful, and we picked out a good number, also many small shells of *Cerithum, Turritella,* and *Scalaria, Fissurella* and *Calyptræa.*

At a larger pit, further on, also in the Coralline Crag, we obtained innumerable *Pectens,* and specimens of *Cardita senilis* and *scalaris, Astarte sulcata, gracilis,* and *Omalii, Cyprina rustica* and *Islandica,* the latter in a regular bed around the pit, and higher up a band of *Terebratula grandis,* of which we procured several fine detached valves, and two small entire pairs, also a very good specimen of a sea-urchin (*Temnechinus*), and many other additions to our scrip.

The Crag is often very much disturbed, and in one pit we visited we saw the Red and Coralline Crag mixed together in most charming confusion.

Our load of specimens now became formidable, and the prospect of a heavy march caused us to hurry away from this grand locality rather faster than either of us desired; but we had planned to reach Orford that night, if possible; so we contented ourselves with securing our present acquisitions safely.

Our obliging guide now volunteered to drive us half way to Orford, and we gladly accepted his offer. We rode across Sutton Heath and Hollesley Common, between plantations and down green lanes, till we pulled up at a neat road-side inn, "The Butley Oyster," where we halted, dismissed our cozy little vehicle and white horse, and after a hasty meat-tea, resumed our knapsacks and crag-shells.

Had it been early day, instead of twilight dim, we should have been tempted to halt and turn aside to look at many a likely pit marked on our Ordnance map; but we had five miles of turnpike before us, and a heavy lot of fossils to carry by turns, and our knapsacks likewise; the road, however, was good, and the evening clear.

After leaving the village of Chillesford (where the Norwich

* See Mr. Busk's interesting monograph on the crag Polyzoa, *Pal. Trans.* 1859.

Crag occurs) we came to Sudbourn Park gate, but not being quite sure of the way through the park, we kept to the turnpike, and soon hailed the Orford lights.

Every village in Suffolk, of any importance, has its "King's Head" and "Crown" inns; we went to the former, and after a night at the "Ramsholt Dock Inn," were both prepared most thoroughly to appreciate this comfortable little place.

Having ordered supper, we sallied forth to inquire for a celebrated character at the "White Hart," known as "Jumbo" (*alias* William Brown). This oddity is a thin, wiry old man, between sixty and seventy years of age, and the most handy fellow in the parish. He is* the living oracle here on Crag-pits and shells, and must be invoked and propitiated with beer and shillings if you want to find the best of both. He is, however, troubled with fits of "brooding melancholy" (the effects of over-potations), when he will not respond to any call, and must be dispensed with. Such was his mood at this time.

His knowledge of Crag-shells places him in a very exalted position, and among the rustics he is considered quite a distinguished palæontologist. Having obtained this information, we returned to our inn, and after supper cleaned and packed our day's collection of Crag.

We were up early next morning, and examined the old Norman arches of the chancel of the original parish church, but found no ferns thereon. Then we visited the Castle, a once famous Norman stronghold, and covering a large area of ground, as may be traced by the green hillocks and remains of ancient stonework here and there protruding through the soil. The view from the summit over Orford Ness to seaward, and inland across Sudbourn park and woods, and down upon the little town beneath, is very picturesque. We gathered a plant of wall-rue, or rue-leaved spleenwort (*Asplenium ruta-muraria*), from the wall of the Oratory (it is still living in my friend's fernery as a memento of our visit). The upper part of this fine old edifice is rapidly falling to decay from neglect.

Orford is an example of a maritime port and fishery from which the sea has been shut out by the formation of an extensive bank of shingle ten miles long, which is only divided from the mainland by the river Alde. This river, which formerly entered the sea five miles north of

* "He is," we ought rather to say "*he was*," for "Jumbo," like the crag itself, is now a thing of the past. Stimulated by a sovereign given him by my friend Professor Suess, of Vienna, "Jumbo" took an overdose of brandy, and, alas! went to the spirit land.

Orford, is now turned south, and runs between the old beach and the new bank for ten miles before it finds an outlet to the sea.* (See Map.)

At other parts of the coast, as at Dulwich, the sea is gaining on the land, and this alternate encroachment and retiring may be seen slowly going on at intervals along the whole eastern and south-eastern coast, and serves to explain by analogy many of the changes in coast-lines which have taken place far back in past ages, the record of which was not kept by man.

As we could not get "Jumbo," we persuaded the landlord to accompany us to the pit in the park where the same great beds of *Cyprina Islandica* and *Terebratula grandis,* which we had observed at Sutton the day before, were again visible. All the best shells were however too brittle (owing to the wet state of the soil) to be obtained entire, so that we got very few rarities.

After dinner "Jumbo" presented himself, and said he had some Crag-shells for sale. We condescended to receive his overtures, and bought 10*s*. worth of him, which made up a pretty complete series, and the whole afternoon was occupied in packing them for London.

The weather had now taken such an unfavourable turn that we decided to forego the examination of the Mammaliferous Crag at Chillesford, and many other Red and Coralline Crag-pits around Orford, where good specimens can be obtained, or interesting sections of the Crag seen.

Although Aldborough may be preferred as offering superior marine attractions to Orford, I am persuaded the latter place affords the best "Head-quarters" to any one who desires to have a pleasant holiday in the country, and collect Crag fossils at the same time.†

* The beach at Felixstow is travelling south in like manner, seriously impeding the navigation at the mouth of the Orwell, near Harwich, and creating the greatest anxiety for the port of Ipswich.

† For figures and descriptions of the Crag fossils, see Mr. S. V. Wood's *Monograph on the Shells*, 2 vols. 1848-56; Mr. Busk's *Monograph on the Polyzoa*, 1859; Mr. Darwin on the *Cirripedia*, 1851, in the *Transactions* of the Palæontographical Society.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1865. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Tension of Vapour.	Relative Humidity.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°	inch.		°	°	°	0—10		inches.
April 1	30·059	45·0	36·3	·314	·74	53·3	44·4	8·9	9, 6, 5	NW by N, NW, NW by N.	0·048
„ 2	...	...	...	...	...	54·5	31·5	23·0	...	... ...	·006
„ 3	29·871	44·9	35·7	·313	·72	53·8	41·1	12·7	1, 7, 8	SE by E, E, E.	·000
„ 4	30·205	46·2	35·3	·328	·68	57·5	37·1	20·4	10, 3, 3	—, WSW, WSW.	·000
„ 5	30·267	47·8	47·5	·347	·98	55·0	40·8	14·2	10, 10, 10	SW, SW, SW.	·004
„ 6	30·261	51·6	45·1	·394	·80	60·1	46·1	14·0	3, 7, 7	SW, SW, SW by W.	·057
„ 7	30·185	52·0	48·1	·400	·88	60·0	45·6	14·4	8, 10, 10	SW, SW by S, SW.	·000
„ 8	30·101	54·7	46·4	·438	·75	67·8	40·2	27·6	6, 2, 0	—, —, SSE.	·000
„ 9	...	...	...	...	...	72·3	38·8	33·5	...	... ...	·000
„ 10	30·241	59·6	44·5	·516	·60	69·4	40·7	28·7	0, 0, 0	NW by W, NNW, NNW.	·000
„ 11	30·206	56·3	42·8	·462	·63	67·6	39·9	27·7	0, 2, 0	SE by S, —, E.	·000
„ 12	30·032	52·3	34·8	·404	·54	62·0	41·4	20·6	8, 7, 8	E, E by S, E by N.	·000
„ 13	29·946	54·2	45·4	·430	·74	64·0	43·5	20·5	2, 7, 8	SSW, SW, SW.	·000
„ 14	...	...	...	...	...	56·3	44·7	11·6	...	... ...	·000
„ 15	30·137	44·1	42·8	·305	·96	53·1	44·1	9·0	10, 10, —	ENE, —, NE by N.	·130
„ 16	...	...	...	...	...	65·4	41·2	24·2	...	... ...	·002
„ 17	29·916	59·9	52·1	·521	·77	68·3	49·7	18·6	10, 10, 10	ESE, SSE, S by W.	·162
„ 18	29·910	56·2	52·9	·460	·89	65·1	51·8	13·3	9, 10, 10	S by W, W, S.	·025
„ 19	30·141	51·4	49·7	·391	·94	60·8	48·0	12·8	10, 10, 9	NE, N, N by W.	·015
„ 20	30·169	52·9	46·9	·412	·81	64·1	44·2	19·9	10, 0, 0	NE by E, NE by E, NNE.	·000
„ 21	30·098	58·0	48·3	·490	·72	71·7	43·1	28·6	0, 0, 4	NE by N, ENE, ESE.	·000
„ 22	30·107	61·8	36·1	·555	·42	73·7	44·9	28·8	0, 0, 0	NE, E by S, E by S.	·000
„ 23	...	...	...	...	...	73·7	41·3	32·4	...	... ...	·000
„ 24	30·223	56·7	44·7	·468	·66	69·0	40·1	28·9	0, 0, 0	NE, NNE, E.	·000
„ 25	30·178	54·1	38·1	·429	·58	66·3	36·2	30·1	7, 4, 0	—, NNE, NW by N.	·000
„ 26	30·109	64·0	40·5	·597	·45	74·5	38·4	36·1	0, 3, 5	—, NNE, N.	·000
„ 27	30·043	67·3	42·5	·665	·43	76·4	45·1	31·3	0, 0, 0	—, WSW, W by S.	·000
„ 28	29·945	57·0	44·6	·473	·66	70·7	42·2	28·5	4, 6, 0	NNE, NNE, ENE.	·000
„ 29	30·040	43·5	32·6	·298	·68	50·8	39·9	10·9	6, 0, —	E, E, —.	·000
„ 30	...	...	...	...	...	50·9	35·2	15·7	...	... ...	·000
Daily Means.	30·099	53·8	43·1	·434	·71	...	...	21·6	...	...	0·449

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—APRIL, 1865.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour. A.M. 12–1	8	4	15	7	9	7	14	2	1	2	3	5	2	3	9	7	16	1	0	20	11	8	6	9	7	0	1	7	20	18	7·4
1–2	8	3	17	6	10	10	14	1	0	0	3	3	1	5	8	5	9	1	2	13	10	8	5	6	7	1	1	5	20	12	6·5
2–3	9	3	14	5	8	10	9	3	0	1	2	3	2	2	6	5	10	2	4	7	10	6	6	8	6	1	0	4	21	12	5·9
3–4	6	4	12	4	9	12	9	0	0	3	2	3	2	4	9	5	12	3	8	13	10	9	8	6	6	3	1	5	21	14	6·8
4–5	6	5	8	2	11	14	6	2	1	2	1	5	3	5	9	7	16	1	10	14	11	5	8	4	5	3	1	5	24	11	6·8
5–6	4	1	8	2	7	13	9	3	0	2	1	2	0	5	6	5	9	3	10	12	11	5	9	6	7	3	2	6	17	12	6·0
6–7	3	4	10	3	10	12	9	3	1	1	2	3	2	5	9	6	10	3	10	14	13	6	9	10	6	3	3	8	15	13	6·9
7–8	7	0	13	3	13	12	12	1	1	5	4	5	0	4	14	10	12	3	10	12	12	12	10	7	6	4	2	3	10	24	7·7
8–9	5	1	14	2	13	11	12	2	2	10	2	5	3	2	12	10	11	6	10	10	13	11	11	14	5	6	3	6	26	27	8·8
9–10	10	2	13	1	16	14	15	1	4	7	3	6	2	3	13	9	9	5	11	12	12	12	12	15	5	5	3	7	30	27	9·5
10–11	12	1	14	5	17	19	13	3	7	7	3	13	4	2	12	13	7	6	12	12	13	12	12	13	7	7	2	11	32	27	10 6
11–12	9	5	14	3	18	17	12	4	5	8	5	17	8	4	11	20	9	7	14	14	14	13	15	15	7	8	7	18	28	26	11·7
P.M. 12–1	12	7	15	5	17	20	10	5	7	9	4	17	11	3	14	25	8	4	15	14	16	10	15	15	9	8	7	10	32	27	12·4
1–2	8	5	14	9	12	21	10	5	8	7	2	20	9	2	13	25	9	8	12	14	18	12	13	14	7	9	7	9	29	24	11 8
2–3	12	14	14	8	13	23	10	8	8	6	3	20	14	2	12	30	10	6	14	15	16	14	13	14	6	8	8	8	31	24	12·8
3–4	13	17	15	10	10	16	10	7	7	10	10	20	16	4	11	30	9	5	12	14	16	19	12	14	6	7	7	14	33	22	13·2
4–5	12	16	15	10	8	18	9	5	8	10	15	16	16	2	12	28	8	13	12	14	16	15	10	14	5	6	7	25	35	23	13·4
5–6	8	12	16	9	8	19	8	6	12	8	13	14	15	5	12	22	5	13	11	14	16	12	10	14	7	6	6	26	29	19	12·5
6–7	5	10	18	11	8	17	5	5	10	6	12	13	13	11	10	18	6	11	15	14	8	11	5	12	3	6	6	22	28	18	11·2
7–8	5	7	10	13	5	12	5	5	5	11	6	9	7	13	10	21	5	10	16	12	9	12	10	11	3	4	8	20	27	14	10·2
8–9	4	6	13	10	6	10	5	1	3	12	4	13	7	13	8	22	6	8	14	13	5	6	7	6	3	8	15	24	26	12	9·6
9–10	8	6	15	10	10	10	4	2	2	11	8	7	6	10	7	20	10	5	18	10	8	1	5	6	4	5	12	23	20	8	8·7
10–11	6	12	10	13	6	10	4	2	2	5	8	9	4	11	5	24	9	3	17	10	7	4	6	5	3	4	10	25	21	9	8·8
11–12	2	13	5	9	7	11	5	3	1	4	5	3	3	9	6	13	4	1	18	9	9	5	9	9	2	1	9	20	20	10	7·5
Total Daily Movement.	177	158	312	160	251	338	219	79	95	147	116	281	150	129	238	380	219	128	275	306	284	228	226	247	182	116	128	306	595	433	9·4

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1865.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		
Day of Month.	Barometer, corrected to Temp. 32°*	Temperature of Air.	Dew Point.	Tension of Vapour.	Relative Humidity.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°	inch.		°	°	°	0—10		inches.
May 1	29·941	49·9	40·2	·372	·71	58·7	33·1	25·6	10, 10, 7	SE, SW, SW.	0·000
„ 2	29·977	56·3	45·4	·462	·69	64·2	45·5	18·7	9, 7, 5	SSW, SW, SW by S.	·075
„ 3	29·841	58·7	46·1	·501	·65	66·3	43·7	22·6	5, 5, 10	SW by S, S by W, S by W.	·002
„ 4	29·848	53·7	52·1	·423	·95	61·7	51·4	10·3	10, 10, 10	SSW, S, S by E.	·055
„ 5	29·674	59·6	50·2	·516	·73	70·0	53·7	16·3	7, 9, 10	S, SSW, S.	·171
„ 6	29·972	55·2	42·8	·445	·65	66·3	46·8	19·5	4, 7, 4	SW by W, WSW, WSW.	·046
„ 7	...	...	...	...	...	58·3	38·7	19·6	...	... ...	·000
„ 8	29·889	55·3	47·1	·447	·76	65·7	38·3	27·4	7, 7, 3	WNW, NE by N, N by E.	·400
„ 9	29·614	58·0	52·2	·489	·82	67·7	49·1	18·6	9, 6, 7	SW, SSW, SW by S.	·143
„ 10	29·502	43·9	44·9	·302	1·00	50·7	46·3	4·4	10, 10, 10	NW, NNW, N by E.	·719
„ 11	29·646	42·6	40·5	·289	·93	50·1	43·6	6·5	10, 10, 10	NNW, NW, WSW.	·465
„ 12	29·881	47·5	40·0	·342	·77	57·7	44·5	13·2	10, 7, 6	SW, SW by S, W.	·135
„ 13	29·984	52·5	36·5	·406	·58	62·0	38·8	23·2	6, 4, 7	SW, SW by W, SW by W.	·000
„ 14	...	...	...	...	...	57·0	47·0	10·0	...	... ...	·094
„ 15	29·622	49·5	46·3	·367	·89	57·3	43·6	13·7	10, 9, 7	SSE, SW, SW by S.	·026
„ 16	29·835	49·8	39·6	·371	·70	57·5	37·8	19·7	8, 9, 8	SSW, SW, SSW.	·003
„ 17	29·900	53·2	46·0	·416	·78	62·7	43·8	18·9	10, 9, 9	S by W, SW by S, SSW.	·020
„ 18	30·121	54·0	38·5	·427	·59	62·7	45·8	16·9	4, 3, 2	NW by N, N by W, NW by N.	·001
„ 19	30·331	59·3	43·1	·511	·58	68·6	41·3	27·3	1, 1, 2	SSW, WSW, W by N.	·000
„ 20	30·289	61·8	39·3	·555	·46	69·7	45·9	23·8	7, 0, 0	ESE, E, E.	·000
„ 21	...	...	...	...	...	78·7	52·6	26·1	...	... ...	·000
„ 22	29·939	65·8	54·5	·633	·69	73·7	53·3	20·4	2, 2, 2	—, S, S.	·644
„ 23	29·977	61·7	54·8	·553	·80	71·8	51·3	20·5	5, 2, 10	SSW, SSW, WSW.	·002
„ 24	30·063	58·2	48·0	·492	·71	66·0	48·9	17·1	7, 5, 2	S, SSE, —.	·190
„ 25	30·112	59·4	48·5	·512	·69	69·9	45·1	24·8	2, 3, 3	—, S by E, S.	·000
„ 26	29·976	64·4	50·8	·604	·63	72·7	42·3	30·4	1, 5, 1	SE by S, S by E, SSE.	·000
„ 27	29·878	61·6	48·7	·551	·65	69·3	52·6	16·7	3, 2, 2	SW by S, WSW, SW.	·000
„ 28	...	...	...	...	...	66·7	54·7	12·0	...	... ...	·084
„ 29	29·882	61·4	54·9	·548	·80	70·8	52·3	18·5	10, 8, 9	SW, SW, S.	·000
„ 30	29·845	56·9	39·6	·471	·55	65·6	55·3	10·3	5, 7, 10	SW by W, WSW, WSW.	·000
„ 31	29·922	57·8	45·4	·486	·65	67·6	49·3	18·3	8, 7, 8	W, —, SW.	·000
Daily Means.	29·906	55·8	45·8	·462	·72	...	...	18·4	...	... ...	3·27

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·067 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—MAY, 1865.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	8	9	5	17	4	11	0	1	12	8	10	11	6	5	4	7	7	8	5	4	10	0	1	7	2						6	6·5
A.M. 1	6	6	5	14	2	9	1	2	13	10	11	10	4	6	2	7	6	7	2	4	10	3	1	8	3						5	6·0
2	5	8	5	11	7	12	1	4	16	9	10	10	4	9	1	6	7	5	4	1	6	1	4	8	3						4	6·2
3	4	9	3	10	9	12	1	1	14	7	6	8	1	6	1	6	7	3	4	0	10	1	1	8	2						5	5·3
4	3	11	3	9	11	9	2	1	16	8	5	9	3	7	3	6	12	5	3	1	7	1	2	8	2						5	5·8
5	3	9	4	9	11	6	1	1	10	7	5	11	2	7	1	6	15	3	2	1	8	6	1	7	2						5	5·5
6	6	13	8	7	10	13	1	1	6	8	7	13	5	10	1	8	15	4	1	2	10	9	2	6	0						6	6·6
7	9	15	18	9	10	14	7	2	5	6	7	14	16	10	2	12	13	6	3	6	10	6	8	4	4						8	8·6
8	6	20	13	11	12	13	14	5	5	6	10	15	17	8	3	14	10	7	0	6	9	4	5	6	3						8	8·8
9	7	23	29	13	20	14	15	3	8	6	9	16	13	7	4	14	14	7	0	4	6	3	10	8	4						5	10·1
10	8	23	30	13	17	16	19	3	13	4	9	17	14	9	7	15	21	7	6	8	5	7	7	12	6						7	11·6
11	16	21	26	11	21	13	13	4	15	3	6	20	13	8	13	13	23	9	6	9	6	5	5	15	0						6	11·8
12	10	24	28	9	20	13	18	4	13	5	7	20	14	8	13	14	28	7	10	9	5	11	5	12	*						5	12·5
P.M. 1	9	25	26	13	19	11	20	9	11	4	6	20	12	6	13	15	24	10	9	11	5	12	6	8							5	12·3
2	9	29	25	15	20	12	18	8	14	5	7	21	10	5	25	15	22	10	9	13	7	11	8	9							9	13·4
3	11	28	22	11	20	14	5	9	12	6	4	22	11	1	21	15	19	9	8	12	10	10	9	17						*	5	12·4
4	8	30	20	14	12	9	16	14	12	5	6	13	9	4	25	17	20	10	9	10	12	9	17	13						15	5	12·8
5	7	22	17	12	8	13	15	11	8	5	7	14	5	3	18	17	18	8	7	8	11	10	10	7						15	6	10·8
6	10	16	20	8	7	9	10	10	7	6	6	13	3	3	12	14	17	6	6	10	8	10	8	4						10	8	9·3
7	5	15	14	13	10	5	6	5	2	10	5	17	1	8	8	10	14	4	2	7	4	6	11	5						13	6	7·9
8	4	12	12	7	11	5	6	5	1	8	5	14	0	5	7	10	14	2	1	7	3	4	8	1						8	3	6·2
9	6	5	12	4	11	6	3	5	1	9	10	8	2	6	8	11	13	2	2	4	1	3	9	2						8	1	5·8
10	10	3	19	4	14	2	2	11	2	11	9	8	6	5	7	7	9	2	5	12	2	2	9	2						8	2	6·7
11	10	3	20	3	13	3	1	12	2	11	11	6	7	4	7	7	10	4	2	11	2	0	7	1						6	1	6·3
12																																
Total Daily Movement.	179	379	384	247	290	243	195	181	218	167	178	330	178	150	206	266	358	145	106	160	167	134	154	178							126	8·8

* No record from May 25th to 30th, Anemometer undergoing repair.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1865.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Tension of Vapour.	Relative Humidity.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°	inch.		°	°	°	0—10		inches.
June 1	29·816	54·2	47·4	·430	·79	64·0	49·3	14·7	4, 10, 10	ESE, E, E.	0·000
„ 2	29·659	49·9	51·4	·372	1·00	59·4	53·3	6·1	10, 10, 10	SW, SW, WSW.	·910
„ 3	29·962	56·3	52·7	·462	·89	67·4	51·9	15·5	10, 9, 1	SW, W by N, W.	·165
„ 4	...	...	...	...	...	69·7	51·3	18·1	...	... ...	·006
„ 5	30·323	61·1	51·4	·542	·72	72·7	49·9	22·8	4, 3, 0	W by N, W, WSW.	·000
„ 6	30·303	65·9	58·2	·636	·78	75·3	58·0	17·3	9, 8, 10	SW by S, WNW, WNW.	·000
„ 7	30·384	59·9	50·8	·521	·73	70·8	58·1	12·7	8, 7, 6	NE, NE by E, E by N.	·000
„ 8	30·467	62·6	51·0	·570	·68	74·5	48·5	26·0	0, 2, 0	—, —, —,	·000
„ 9	30·330	67·8	55·8	·676	·67	78.4	53·5	24·9	0, 0, 1	W, —, —,	·000
„ 10	30·131	63·0	51·1	·578	·67	72·0	53·3	18·7	3, 8	NW by N, NW by N, NW by N.	·000
„ 11	...	...	...	...	...	62·1	49·3	12·8	...	... ...	·000
„ 12	30·439	54·1	38·8	·429	·59	63·9	41·2	22·7	0, 5, 2	NE, NE by N, NE.	·000
„ 13	30·396	63·1	47·8	·580	·60	74·1	46·6	27·5	0, 0, 1	NW, NW by N, N by E.	·000
„ 14	30·355	63·8	52·7	·593	·69	73·9	49·3	24·6	0, 0, 0	—, E by S, E.	·000
„ 15	30·369	61·1	52·2	·542	·74	71·4	45·3	26·1	0, 5, 2	—, NNE, NE by N.	·000
„ 16	30·391	56·1	45·4	·459	·69	65·6	51·3	14·3	8, 6, 1	NNE, NE, N.	·000
„ 17	30·341	57·1	47·9	·475	·73	67·2	49·6	17·6	4, 3, 2	NE, NE, NE by E.	·000
„ 18	...	...	...	...	...	56·7	47·7	9·0	...	... ...	·000
„ 19	30·324	55·7	48·0	·453	77	69·6	49·2	20·4	10, 1, 0	NE, E by S, N.	·000
„ 20	30·325	64·1	44·6	·605	·51	75·7	42·5	33·2	0, 0, 0	NE by N, ENE, E.	·000
„ 21	30·306	72·8	43·4	·795	·37	83·6	42·3	41·3	0, 0, 0	—, —, S by E.	·000
„ 22	30·286	64·6	53·3	·609	·68	78·4	51·8	26·6	0, 0, 0	NE, N by E, E.	·000
„ 23	30·132	72·9	48·8	·798	·45	82·7	50·0	32·7	4, 7, 1	W by N, NNW, W.	·000
„ 24	30·159	58·3	40·8	·494	·55	67·9	58·7	9·2	3, 6, 7	N, N, NNW.	·000
„ 25	...	...	...	...	...	72·7	51·9	20·8	...	... ...	·000
„ 26	30·115	56·6	54·0	·467	·92	65·4	51·6	13·8	10, 10, 10	W. by N, W by N, WNW.	·000
„ 27	30·168	62·3	58·0	·564	·87	73·7	55·5	18·2	10, 8, 9	SW, S, S.	·000
„ 28	30·007	63·3	58·3	·583	·85	74·0	...	...	10, 9, 9	SE by E, SE by E, SE.	·000
„ 29	29·557	54·7	57·9	·438	1·00	63·3	54·2	9·1	10, 10, 10	ENE, W by N, NE by E.	·008
„ 30	29·313	52·0	54·0	·399	1·00	61·8	54·9	6·9	10, 10, 10	NNE, ENE, N by E.	·490
Daily Means.	30·167	60·5	50·6	·541	·73	...	...	19·4	...		1·579

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JUNE, 1865.

Day. / Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
12	2	21	14	4	1	3	5	2	4	3	5	3	4	4	1	6	11	9	13	1	1	7	5	4	2	11	2	3	12	13	5·9
A. M. 1	7	19	12	3	2	5	6	1	3	1	15	4	4	3	2	7	11	9	12	3	3	6	1	3	2	8	3	5	13	10	6·1
2	9	17	10	2	2	4	3	3	5	2	9	4	4	1	2	4	13	9	11	1	1	4	1	3	2	6	4	5	11	9	5·3
3	8	15	12	3	3	3	5	1	4	1	9	6	4	1	1	11	12	9	11	1	1	4	1	6	3	6	5	4	8	8	5·5
4	7	6	11	2	1	4	3	2	5	1	9	7	4	1	1	10	14	8	7	2	1	6	1	14	4	6	3	5	7	6	5·3
5	11	9	11	4	4	3	11	2	6	2	8	7	3	1	0	10	11	10	10	2	1	6	1	14	5	9	3	5	5	5	5·9
6	19	19	14	3	6	4	10	1	5	1	13	10	3	2	1	13	13	12	10	2	1	9	4	15	6	10	3	6	7	8	7·7
7	18	17	18	3	7	3	11	2	4	5	14	10	4	5	1	11	13	12	10	1	1	6	4	14	10	10	2	6	7	10	7·8
8	25	14	10	5	8	4	9	3	5	6	13	13	3	2	3	14	12	13	11	3	2	5	5	15	11	8	3	9	9	12	8·6
9	30	20	9	9	8	6	11	2	8	7	12	11	5	4	2	20	10	13	9	3	2	7	5	15	11	7	5	9	8	13	9·3
10	31	22	7	6	7		12	2	8	10	10	12	5	5	4	18	15	15	8	7	4	6	8	15	11	7	4	11	6	12	10·0
11	26	24	7	6	8		15	4	9	12	13	13	7	6	7	15	17	13	8	5	5	5	11	13	13	8	3	12	5	10	10·3
12	27	23	7	8	8		14	6	10	11	15	13	5	7	5	19	15	14	9	6	6	6	11	15	14	5	4	10	9	13	10·8
P. M. 1	22	31	7	6	9	53	11	4	7	11	15	23	6	10	5	20	16	13	8	6	7	5	10	14	13	10	4	11	5	11	11·1
2	24	17	9	7	8		13	2	6	12	15	13	7	11	4	20	15	14	7	4	4	7	10	13	13	7	6	10	4	10	10·1
3	25	16	11	5	8		16	4	5	14	12	11	7	12	6	18	14	14	8	8	2	6	10	10	12	5	6	11	4	4	9·8
4	25	16	13	5	9	7	19	1	7	11	15	10	6	14	5	19	14	12	8	11	6	10	12	11	14	5	6	10	7	10	10·6
5	23	25	11	4	8	7	14	2	5	12	15	8	9	12	4	16	16	11	11	13	6	9	13	7	13	7	4	8	8	10	10·4
6	28	22	8	1	5	7	12	2	5	9	8	5	9	14	4	15	18	11	10	11	10	9	10	8	9	8	4	8	9	8	9·4
7	16	13	8	2	3	5	10	6	8	9	14	3	6	9	8	15	12	13	10	9	6	5	8	7	11	5	4	8	10	10	8·4
8	16	21	4	0	2	3	8	3	11	11	13	4	7	10	9	15	9	10	13	7	3	4	6	7	9	3	7	11	8	10	8·1
9	20	13	3	1	2	3	9	3	11	6	10	3	7	9	8	12	4	13	8	6	7	2	6	6	9	2	5	12	8	14	7·4
10	22	12	4	1	4	2	10	8	8	7	6	3	7	4	7	12	5	13	6	2	9	3	7	5	8	3	5	16	12	15	7·4
11	20	11	5	1	3	5	7	3	5	5	3	1	4	3	8	16	6	12	2	1	5	5	5	3	2	2	3	14	12	17	6·3
12																															
Total Daily Movement.	456	428	220	91	126	131	244	64	154	160	271	197	180	150	98	336	206	282	220	115	94	142	155	237	207	158	98	200	194	248	8·2

AIDS TO MICROSCOPIC INQUIRY.—No. VI.

The Illumination of Objects.

The right method of illuminating microscopic objects is a most important subject of inquiry. The beginner finds one of his chief difficulties in the arrangement of illuminating apparatus, and the most practised and scientific manipulators are continually occupied with questions only differing in degree from those which puzzle the student at the commencement of his career.

The object of illumination is of course to show all that the glasses employed can render visible, and to do so in such a manner as to make microscopic vision as easy and as little fatiguing as the ordinary exercise of the unaided eye. The beginner usually finds his arrangements in excess on one side or the other. Either his object is too much in the dark to be distinctly visible, or his field is flooded with so much light as to distress the eye, and render it impossible to discover delicate structure. The more experienced microscopist avoids these errors, but is apt to indulge in pet methods of illumination, and to assume, from appearances presented under peculiar circumstances, that he knows all the microscope can tell him concerning the objects he surveys.

It is well at the outset of microscopic experiments to inquire what effects illumination can produce. It is obvious that we only see objects by means of their action upon light, and we can learn whether they reflect it or transmit it, allow it to pass straight through them, or bend it out of its course. If we illuminate them with white light, and see them coloured, it is plain that they have prevented certain rays from reaching our eyes either by interception or absorption, or by sending them in another direction.

From this statement of the results that become visible when objects are under illumination, we may proceed to the consideration that if an object is of a composite structure, we may treat it so as to show the kind and degree of action which its several parts can exert upon light under different circumstances. When the microscope is employed to investigate any structure, we must arrange the illumination so as to test it in various ways. Each mode of illumination may teach us something not visible under another method, and by putting the results of various methods together, we arrive at conclusions concerning structure that either could not be reached at all, or not safely reached from any single method of optical investigation.

Apart from their form, the various parts of any small object of

a transparent description, and viewed by transmitted light, can only differ from each other by showing colour, by transmitting light in different proportions, by refracting light with different degrees of force, or by polarizing it, and thus rendering it incapable of transmission through certain bodies in all directions. We shall omit the question of polarization, and notice the other actions mentioned. Where difference of colour exists, it is very important in enabling us to distinguish one part of a structure from another. Coloured objects should be examined by white light, and care should be taken not to let it be so strong as to obliterate delicate tints. Varying degrees of transmissive power, and varying degrees of refractive power, operate within certain limits in much the same way. The most transparent portions of an object let most light through, and the least refractive bend the least light out of its straight course to our eyes. Thus the chief effect of contrast between more and less transparent parts, and more or less refractive parts of any object will be analogous—namely, that of stopping a greater or less transmission of light to the eye. Refracting bodies exert a power of dispersing or separating white light, which consists of rays of all sorts of colours, into distinct colours, according to their several refrangibilities. When this power is strongly exerted, very positive colours, as in the prismatic spectrum, appear; when feebly exerted, a slight difference of tint is noticeable, and that is all.

Suppose we have to examine a beautiful diatom, such as Arachnoidiscus, or a live transparent object, such as a rotifer, our object is to illuminate the one or the other, so as to enable nice gradations in refracting or absorbing power to be seen. The first thing to be done is to send the light in a good direction, and the second to regulate its quantity, and vary the quantity within certain limits either way. If a lamp is placed as far off an ordinary bull's-eye condenser as its focal length, it will transmit parallel rays—that is to say, its power of bending rays will just compensate or bring straight the divergence of the rays from all parts of the lamp that will fall upon its surface. Such parallel rays may be thrown upon a flat mirror, and sent up straight through our object. We have then illumination in its simplest form. We must apportion the quantity of light to the delicacy of the object; and if this is done, we shall see that some parts allow more than others to reach our eye. Careful experiments should be made in varying the quantity of light transmitted without changing its direction. The easiest mode of doing this is by means of an elegant piece of apparatus lately introduced by Mr. Collins; we mean his "Graduating Diaphragm." An instrument of this kind appears to have been made long ago by Dollond; but Mr.

Collins probably did not know this, and his plan is better. The "Graduating Diaphragm" fits under the stage like the common revolving diaphragm, and a screw movement enables the aperture to be reduced almost to a point, or opened to considerable extent. By this means it is easy to find the exact quantity of light that gives prominence to the most transparent portions of an object, and then to add more light until its more opaque parts transmit what they can. In the absence of this instrument, which we strongly recommend all microscopists to adopt, the gradations of light should be obtained by other means, such as using the ordinary diaphragm, turning the lamp higher or lower, interposing screens of paper rendered partially transparent by spermaceti, etc., etc.

If after having gone through a series of experiments in which light is allowed to reach the object straight, or at right angles to its flat surface, and we have ascertained the effects of carefully regulating the bulk of the illuminating beam and its intensity, we next proceed to change the direction of the light, the appearances will be modified: a slanting beam will pass through thicknesses different from those which a straight beam traverses. If the slant is sufficient to cause the rays of light, in the absence of any object, to go away from our eye, and the presence of an object allows us to see them, this effect can only be produced by the refractive power of the object, or of certain portions of it. If some parts do not refract the light so sent, they will look dark, while the refracting portions will look light. We must still pay great attention to the quantity of light transmitted, and by varying the quantity we shall obtain different effects.

Slanting illumination of transparent objects may be one-sided or all-sided, or something between the two. That is, by means of various pieces of apparatus we may send a pencil of light from one direction, or from two directions, or from all sides at once, and the effects will vary in each case. Very slight changes of direction in the light pencil will cause noticeable differences in the aspect of delicate objects. For example, if we employ an achromatic condenser, we shall find that a slight change in the angle of the mirror, throwing the light up through it, will cause the appearance of diatoms, or delicate live objects, such as infusoria, to differ to the extent that certain evidences of structure come and go, as the position of the mirror is changed.

Every object examined by the microscope has an appreciable thickness, and we can easily perceive that its appearance must vary according to the angle of which the light strikes it. A very oblique light acts almost entirely on the surface, and if properly directed and regulated, can give us surface,

and often *superficial* information. If we want, after having seen the surface, to look below it, we must not allow any rays of too much obliquity to fall upon the object; but try various changes, between light sent right through it at right angles to its flat surface, and light transmitted with moderate degrees of obliquity. In such experiments the size of the illuminating pencil and its intensity both require adjustment, and although a certain best position or arrangement may be obtained, others that are on the whole worse may yet give special information necessary for the right understanding of the object.

In illuminating transparent objects, we can employ the simple mirror, the mirror with diaphragm, the achromatic condenser, or similar contrivances; but in all cases we are regulating direction and quantity of light, and nothing more. If we stop out the marginal rays of a pencil of light emerging from a lens, we are simply determining that no rays shall reach the object but such as have little divergence. If we stop out the central rays, and allow only the marginal ones to be transmitted, we are merely providing that the object shall only be lit by rays of greater or less divergence, and not by any rays that are parallel, or have a small divergence.

With objects of considerable refractive power, we may employ rays so oblique that they would escape us entirely if they were not bent up towards our eyes. The spot lens and the parabolic illumination thus give a dark ground illumination with appropriate objects. They succeed beautifully with objects of sufficient refractive power, and they fail with those that do not possess it in the requisite degree. When objects contain two substances, or the same substances in two forms, in the one case highly refractive, and in the other highly transmissive and freely refractive, the illumination that displays the one to advantage will not show the other, and any reasoning founded upon one view only will be unsound. In like manner, if two parts differ much in transparency, one illumination cannot be equally advantageous for both.

In displaying objects to our friends we should adopt a mode of illumination that is generally accommodated to their peculiarities, but in studying them by ourselves we should ring the changes upon all the modes of illumination of which they are susceptible.

The achromatic condenser, with its variety of stops, has hitherto been the most important instrument for transparent illumination; but recently Mr. Highley has introduced an invention of Mr. Webster that may wholly or partially supersede its use. This apparatus consists of a large achromatic combination, with a plano-convex lens in front of it. It is furnished with stops somewhat like the ordinary achromatic con-

denser, and gives an illumination from a high degree of obliquity to one consisting of a small pencil of nearly parallel rays. Mr. Highley is at present engaged in devising improvements in this instrument, and we shall take an early opportunity of describing its most finished form, merely saying at present that it promises to be of great service to microscopists, from its utility and comparatively small cost.

Various experimenters have tried the effects of monochromatic light. We do not know who began such trials. We commenced them several years ago by affixing flat discs of coloured glass on the flat side of an ordinary bull's-eye condenser. Probably very small pencils of light would be most successful, and Mr. Collins' "Graduating Diaphragm" would facilitate such experiments. Red light, as least refrangible, and violet light, as most so, would give the most conspicuous results; but there are occasions when objects are well seen on a coloured background, and we remember Messrs. Powell and Lealand making an interesting exhibition of this kind.

In our last number (page 481) we mentioned that the Abbé Count Castracane employed—as is stated, with success on diatoms—Foucault's heliostat and a prism of large dispersion. For the *Pleurosigma angulatum* he found a blueish green light the best. As a rule, we should distrust the effects produced in the glare of sunlight illumination, but there are occasions when some observers consider it may be used with advantage.

In illuminating opaque objects the direction of the light is highly important. A pleasing instance of this occurs in the display of the mineral called hyperstene. A ray of nearly perpendicular light makes this object look as unlovely as a piece of coal, while one of exactly the right slope brings out gorgeous colours, often arranged like a series of Chinese pictures of landscapes and rivers. Mr. Sorby found in some of his important researches that the structure of certain objects could only be made out by nearly vertical illumination, and Messrs. Smith and Beck constructed some apparatus adapted to this want. For ordinary purposes a side silver reflector, which is best mounted on a separate stand, is an admirable illuminator, as it enables the operator to transmit rays of varying obliquity, though none as vertical as in the arrangement just described. There has been a tendency of late years to undervalue the lieberkuhn, but this is a mistake. It can be used well with object-glasses from one inch to a quarter, if not focussing too close, and by varying the position of the mirror the light may be condensed more strongly on one side than on the other. It would probably be worth while trying the experiment of limiting the size of the pencil of light reaching a lieberkuhn by

means of Mr. Collins' "Graduating Diaphragm," or by some other contrivance.

Those who have contented themselves with ordinary modes of illumination will be surprised at the variety of effects to be produced with the same slide by different methods of lighting it up. As a mere source of amusement, nothing can be pleasanter than to spend an evening or two in trying experiments of this kind. Very transparent objects should be tried with different-sized pencils of light, composed of rays either very divergent, or nearly parallel, and with all grades of intensity. Highly refractive objects, which are at the same time good reflectors, such as many of the polyparies of compound polyps (*Sertularia*, etc.), or plyzoaries (as the abodes of compound associated polyzoa have been called), are very fit for experiments, with varying angles of opaque illumination obtained by bulls'-eyes, lieberkuhns, or side reflectors, and also for other experiments with spot lenses, parabolic illuminators, or the dark ground stops of Webster's condenser. All the large diatoms, hairs of animals mounted in Canada balsam, parts of insects, etc., should be treated in the same way. Many objects are nearly equally fit for transparent, opaque, and dark ground illuminations, and, as we have before remarked, an inferior mode of illumination often brings out some specialty which a better mode fails to show.

In all these experiments it must be remembered that the appearance produced may vary greatly, according to the angle at which the illuminating pencil reaches the object. Even with the same mode of illumination, dark ground, transparent, or opaque, projections or depressions will be seen or not seen, in proportion to the skill which the angle of an illumination is managed. An object may look flat with one illumination, and be seen to have a varied contour the moment another is employed.

THE PLANET SATURN.

It is to be regretted that the gradual opening of the ring-system of Saturn should be associated with his downward progress into the constellations of the wintry zodiac. During the last season, though the steady air of the warm June evenings permitted his features to bear a closer scrutiny than might have been expected from his position, astronomers must have longed for the clearer views of a higher altitude; and they will have still more cause for dissatisfaction for some years during his future visits to our midnight sky. This will not only be a source of disappointment to the mere ordinary "star-gazers," but to those who are anxious to use their powerful instruments in exploring the mysteries of this most mysterious system. Poulkowa will be entirely *hors de combat*, and even Harvard much less qualified than it formerly proved itself to deal with those minute details, on the correct perception of which the interpretation of the larger features will probably be found to depend. The necessity of future scrutiny is sufficiently evident, and in this impatient age we are little disposed to acquiesce in the long delay that must elapse before that slow revolving planet brings round his opened ring at a suitable altitude above our horizon.

These observations are not so much prompted by the recent withdrawing of the planet into the evening twilight, as by the appearance of a remarkable work, bearing the title of *Saturn and its System*,* which is well deserving of the study of those who feel an interest in this wonderful object. The book is constructed on a most comprehensive plan, embracing both the mathematical and physical aspects of the subject, discussing at great length many of the curious questions which so naturally arise out of it, and comprising a great number of elaborate tables, which seem to have been prepared with extreme care. Although, however, it contains a great deal which it would give much trouble to find elsewhere, and some things which appear to us of a very original character, we cannot say that nothing has been omitted which might be expected in a really complete and exhaustive monograph, especially in regard to details of physical structure. Here we cannot but feel the want of a more extensive recognition of the results obtained by the best authorities of the present day. No allusion, for instance, has been made to the singular distortion of the outline of the shadow of the ball upon the ring, so apparent in the designs of De la Rue, Lassell, Bond, and Secchi, and so difficult to be

* *Saturn and its System.* By Richard A. Proctor, B.A. Longman and Co. 1865.

accounted for on any supposition consistent with the extraordinary flatness and thinness of the shaded body. Nor is any reference made to the alternate difference of colour remarked by Lassell in the two ends of the "crape veil," nor to the researches of De la Rue as to the eccentricity and irregular breadth of the several portions of the ring, or the deviation of the dusky ring from the plane, or planes, of its neighbours. Besides these omissions, a few inaccuracies might be pointed out here and there; and we should have been altogether better pleased with a fuller system of reference to original authorities. But we should be sorry to detract from the general merit of a book in which, if the reader does not find everything which he might expect from its title, he will certainly meet with much that will repay the perusal, to say nothing of the very clear and beautiful illustrations which accompany it; some of which, however, would have been improved by a closer following of De la Rue's exquisite portraits.

The student may probably be most struck by the hypothesis which, in consequence of the researches of Mr. Maxwell (author of the Cambridge Prize Essay on this subject in 1857), the writer has adopted as the most plausible explanation of the structure of Saturn's ring. It is composed, according to him, of a dense flight of satellites, so closely grouped as to escape individual recognition at our great distance, yet revolving each in its separate orbit in such a manner as to secure the general permanency of the system. This idea, which is of considerable antiquity, being at least as old as the time of Cassini II., is much less fanciful than might be supposed by any one unacquainted with the difficulties of the subject. For though the telescopic aspect of the ring produces unquestionably the impression of continuous solidity, and this would seem to be indicated by its black shadow upon the ball, yet on recognized dynamical principles that condition is found to be impossible. We may perhaps be excused for not assuming as confidently as Mr. Proctor has done, that the period of the ring's rotation is determined beyond all doubt; our impression being rather that the evidence from which it has been deduced is somewhat slender; but the fact of such a rotation seems necessarily implied by its continuous existence under the power of gravity. Whatever period, however, we assume for the rotation, it cannot theoretically suit the whole breadth of the ring, each appreciable portion of which would require a distinct time of rotation, in proportion to its distance from the planet. And hence, had it been supposed originally solid, it would have been torn asunder by the strain, and broken up into an assemblage of minute concentric rings, or, as Mr. Proctor prefers to think, into an immense mass of distinct satellites.

This is more comprehensible when we take into account the extraordinary thinness of the ring, assumed by him at 100 miles, but reduced by Bond to less than 40. With its breadth of some 26,000 or 28,000 miles, it is very conceivable that, as Mr. Maxwell has asserted, it would be "not only plastic but semi-fluid under the forces it would experience," even if it were made of iron! The American theorists had preferred the hypothesis of its consisting of a number of streams of fluid a little denser than water; and the supposition has even been entertained, and might we believe be maintained with some plausibility, that it is of a vaporous nature. The fact is—and we think it would be most readily admitted as such by those who have most closely examined the object—that it is extremely difficult to form any idea of its real nature from observation; and so long as that is the case, it offers a wide field for the admission of dissimilar theories. The existence of the inner dusky ring Mr. Proctor refers to thinner strata of satellites, which have been detached by the attraction of the globe from the more luminous mass, without ceasing to circulate round it. But, whatever may be thought of this speculation as applied to the bright rings, we must say that it appears to us inadmissible here. Without laying too much stress on the circumstance that the inner edge of the luminous ring is usually much more clearly distinguished from its darker neighbour than might be expected on that supposition, we must think that the aspect of the dusky ring in front of the ball is quite inconsistent with it. In such a position, the existence of a thinly scattered stream of light-reflecting satellites would be barely, if at all, perceptible in the most powerful instruments, instead of its challenging the eye so distinctly, even in smaller ones, as a dusky zone, that it has been sometimes even mistaken for the shadow of the bright ring. Mr. Proctor's hypothesis would naturally be connected, as he has shown, with such a decrease in the dimensions of the ring as has been attempted to be proved by Otto Struve from a comparison of the older and more recent drawings and measurements; but he has not adverted, as might have been expected, to the circumstance that in consequence of the very careful investigation of Mr. Main, Struve's result has not received the general concurrence of, at least, the astronomers of England.

We might enter into further detail, but this may suffice. Our readers will have inferred our conclusion, that, notwithstanding much diligent study and praiseworthy labour, the subject is still not exhausted, and requires, as it deserves, to receive a more extended elucidation. But for this it will be better to wait till future observation has supplied more satis-

factory materials for theory. And we must not forget that, though any essential advance may for some years to come be denied to Europe and the United States, yet there are Southern observatories which will not, we hope, be idle during the increasing expansion of the ring. We have heard with much regret, and trust it may prove to be an unfounded report, that Mr. Lassell's munificent offer of his 4-foot reflector has been declined by the authorities at Melbourne. But should this unfortunately prove true, we trust that they will feel the obligation they have incurred, to do something which may prove that the course which they have adopted was not the result of indifference to the progress of astronomy.

The telescopic researches into the structure of Saturn and his appendages, which are very imperfectly traced, or omitted, by Mr. Proctor, are so important and interesting, that our first intention was to embody an account of them in this paper; but, upon further consideration, we thought it best to postpone this inquiry, in the hope of recurring to it in a separate article at no very distant time. The numerous contributions to this branch of observational astronomy by Mr. De la Rue would, in themselves, demand a longer and more careful treatment than we could give them at the present moment; and it would be necessary to collate and compare them with the researches of other eminent observers to whom allusion has been made. Another reason for deferring the consideration of this subject is, that it has been suggested to us that it would be more welcome when Saturn is returning to our skies, than when he is passing away from our view.

LITERARY NOTICES.

ICE CAVES OF FRANCE AND SWITZERLAND: A Narrative of Subterranean Exploration. By the Rev. G. F. BROWNE, M.A., Fellow and Assistant Tutor of St. Catherine's College, Cambridge, Member of the Alpine Club. (Longmans).—So little is generally known concerning even the existence of those curious natural objects—ice-caves, or *glacières*—that Mr. Browne's pleasantly-written narrative of his explorations will have the charm of complete novelty to most of his readers. The general conditions of an ice-cave are, first, the existence of a great hole in the ground, at a considerable elevation. The cave must be protected by its shape and local conditions, not only from direct solar radiation, but also from the entrance of warm currents during the summer months; and lastly, there must be, from infiltration or some other cause, a supply of moisture to be frozen when a sufficiently low temperature prevails. Thus, the *glacière*, or ice-cave, is an ice-factory and ice-house combined. During the greatest heat it must not be so affected by the external air as to reach, for any length of time, a temperature much above the freezing point. There may be a little thaw; but there must not be enough to prevent a good stock of ice remaining till the period of fresh ice formation comes round again. The traveller desiring to visit these very curious natural formations climbs a few thousand feet up some mountain slope, then finds a more or less abrupt entrance to a cave, which he usually descends, partly by means of ricketty, half-rotten ladders, and partly, when the slope admits of it, by the help of steps cut in the ice. In Mr. Browne's case he was accompanied in many explorations by two adventurous sisters, who braved the difficulties and dangers of subterranean travelling, and seem to have got on famously, when divested of crinoline. Walls of ice, sheets of ice, stalactites and stalagmites of ice, columns of ice, and ice in a thousand fantastic forms gratified the explorers, and Mr. Browne's descriptions, in addition to their scientific value, form a very readable volume, likely to tempt many of his fellow-creatures into leaving the sunny regions of the day, and plunging down into the damp, cold bowels of the earth, at the risk of rheumatism and catarrh. Mr. Browne himself prudentially dined and cooled outside the ice-caves before encountering their dark and wintry depths, and his brave sisters very wisely compounded wholesome prophylactics, by mingling brandy with ice or snow.

Some *glacières* are reached by first descending a deep pit, others begin with a slope, more or less impracticable. In the case of the "Glacière of Monthezy," after scrambling down rough, steep, and wet rocks, the party came to an "abrupt slope of mud," and "a buttress of damp earth," in which it was necessary to cut deep holes for the hands and feet before even a man could venture upon the attempt with comfort." The man and the praiseworthy women who could find "comfort" under these circumstances, certainly deserved the reward of something worth seeing when their labours were done, which, however, was far from

being the case after the mud part of the passage was accomplished. That merely brought them within sight of a ladder twenty-one feet deep, and having only seven steps. The cave had other entrances which were worse, and so the ladder descent was made, and conducted the explorers to a low entrance, from which a strong cold blast was blowing. The greater part of the cave was too low to admit of standing upright, and was, of course, quite dark; but there were three domes, beneath which the erect posture could be changed for the reptilian mode of progression over the cold, sloppy floor. We can understand that the adventurers "hailed with delight" one of these domes, and "this delight was immensely increased when our candles showed us that the walls of this vertical opening were profusely decorated with the most lovely forms of ice. The first that we came under passed up out of sight, and in this two solid cascades of ice hung down, high overhead, apparently broken off short, or at any rate ending very abruptly; the others did not pass so far into the roof, and formed domes of very irregular shape. In all three the details of the ice decoration were most lovely. . . . The candles in our hands brought out the crystal ornaments of the sides, flareing fitfully all round us and overhead, as if we had been surrounded by diamonds of every possible size and setting." In another dome "on every side were branching clusters of ice, in the form of club mosses, with here and there varicose veins of clear ice, and pinnacles of prismatic structure, with limpid crockets and finials." Many other ice-caves explored by Mr. Browne were equally curious with that of Monthezy, and what we said concerning his book will, no doubt, determine our readers to consult its pages for themselves.

On Radiation: The Rede Lecture, delivered in the Senate House, before the University of Cambridge, on Tuesday, May 6, 1865. By John Tyndall, F.R.S., Professor of Natural Philosophy in the Royal Institution, and in the Royal School of Mines. (Longmans).—This is an excellent summary of the leading facts concerning the radiation of light and heat, absorption, etc. It is written in Professor Tyndall's well-known interesting style, and is characterized by his usual power of making a difficult subject intelligible, by approaching it gradually and in the right way.

A Dictionary of Science, Literature, and Art: comprising the Definitions and Derivations of the Scientific Terms in general use; together with the History and Descriptions of the Scientific Principles of nearly every branch of Human Knowledge. Edited by W. F. Brande, D.C.L., F.R.S., L. and E. of Her Majesty's Mint; and the Rev. George W. Cox, M.A., Late Scholar of Trinity College, Oxford. (Longmans.) Parts III. and IV.—The first volume of the new edition of this work is completed by Part IV., and on the whole it appears to us very well calculated to answer the purpose described in the preface, namely, that of providing a cheap cyclopædia, containing a well-selected series of articles. Of course, in order to keep down bulk and price, many things must be omitted that ought to be found in larger and more costly works;

but there are thousands of families and students who will be glad of such a work as is now offered, and in extending it to three volumes the editors have, in our opinion, acted wisely. It enables them to take a middle position between prolixity and incompleteness, and for many years to come the new edition will occupy an important place amongst really serviceable books.

COMPARATIVE GEOGRAPHY. By CARL RITTER, Professor of Geography in the University of Berlin. Translated by W. Gage. (Blackwood and Sons.)—This publication brings within reach of English readers a very valuable course of lectures on comparative geography, by the late Carl Ritter, who occupied the highest place in this branch of science. It describes the surface of the earth in its most general relations, and then proceeds to special considerations, such as the contrast of land and water hemispheres, the historical element in geography, plateaus, mountains and mountain lands, plains, lowlands, courses of rivers, etc., etc. It is one of those admirable works that suggest a philosophy as well as provide facts, and will form a valuable addition to the well-selected family library.

The ANTHROPOLOGICAL REVIEW, No. 9 and 10. (Trübner and Co.)—In the last number of this publication of the Anthropological Society will be found the papers attacking missions and missionaries, which created a sensation in the religious world, and also the remarkable defence of missions by Bishop Colenso. The Anthropological Society has made itself very notorious, and now boasts of some six hundred members, which is a great success, so far as numbers are concerned. During the American war, when philanthropists hoped that that terrible struggle would eventuate, as it has done, in the abolition of slavery, the Society ran a-muck at the negroes, as though a reckless and heartless abuse of black men was the chief duty of the time. Such conduct, of course, made a sensation, and when that sensation was subsiding, another was got up, by assailing missionaries and their converts. Neither in the negro case nor in the mission case was there anything like scientific accuracy, or sobriety of discussion; and though the Anthropologists have certainly become notorious, their scientific reputation is yet entirely to be made, and if it is ever made, their mode of operations must be entirely changed. We should certainly not condemn them for bringing forward unpalateable truths. If too much capacity for civilization is assigned by many benevolent people to the negro race, let the error be exposed; and if too much is claimed on behalf of missionary action, let a more exact estimate be made; but a scientific society ought to avoid the recklessness and rancour that characterize too many political and theological disputes. To single out the negro race, as if no other race was difficult to civilize, was obviously unfair; and to speak as if missionary efforts were the only or most remarkable instances of failure on the part of the white man to improve black men, is to show a similar disregard for accuracy, if not for truth. The fact is, that our civilized races are nearly uniformly unfortunate in their dealings

with races occupying an inferior position. When they came into contact with an inferior race, their tendency is to destroy it rather than to elevate it, and neither merchant nor missionary succeed in producing those extensive changes for good which we think ought to be the result of civilization acting upon comparative barbarism. If the Anthropological Society can tell us how to improve existing methods of teaching industry, and morality, and religion, their services will be welcomed; but indulging in throwing stones at other folks contributes in no wise to this end.

ENTERPRISE AND ADVENTURE, being the second volume of the "Temple Anecdotes." (Groombridge and Sons.)—The present volume of this capital series consists of a very numerous and interesting collection of original articles, embodying the best stories of enterprise and adventurous exploration. The editor conducts his readers to sojourn with Belzoni in Egypt, with Dr. Wolff amongst the Affghans, with Huc and Gabet to Tartary, with Humboldt to the banks of the Orinoco, and with Markham in Peru, and deals in like manner with many other travels and travellers of importance and fame. The selection and treatment of the subjects is alike judicious, and thus this portion of the "Temple Anecdotes" provides a fund of exciting reading, in which the stimulus is of a thoroughly wholesome kind. Literature of this class can be honestly recommended, as calculated to rouse the young to a perception of the great fact, that the real dignity of life consists in its noble sentiments and in its useful work.

HARDY FERNS: HOW I COLLECTED AND CULTIVATED THEM. By MONA BELLAIRS. With a Frontispiece. (Smith, Elder, and Co.)—Miss Bellairs has wisely provided herself with an object in her pleasure trips, and she discourses in a lively manner concerning her expeditions in various parts of the three kingdoms in search of ferns. Her book is very prettily got up, and will no doubt stimulate others to follow her example. Most of her advice is very good, but we should not like to promise much success to any one who made a fernery in a place as much exposed to sun as she recommends. Most ferns fitted for out-of-door growth in this climate like warmth, but they like it as they get it in their favourite haunts, which are seldom exposed to the noontide blaze.

A HANDBOOK OF BRITISH PLANTS. Designed especially for Schools, Senior Classes, and Excursionists. By G. LOWNDES NOTCUTT, Author of *Handbook of the Microscope*, *The Geography of Plants*, etc. (Longmans.)—Mr. Notcutt explains in his preface that he has no intention of competing with the larger floras of Babington, Hooker, and Bentham, but intended to produce a portable introductory volume, which could conveniently form a pocket companion for the excursionist, or a handy text book for the student. The book begins with a brief analysis of natural orders, then we have a description of genera, and lastly a descriptive list of species. In each division the student is led on by the method of agreement or discrepancy now employed by all the best botanists. Having ascertained the order of a plant, the list of genera is to be

consulted, looking down the descriptions until one is found to fit. Then the list of species is resorted to in the same way. Mr. Notcutt appears to have compressed a great deal of information into a small space, and his method is clear.

ARCHIVES OF MEDICINE. Edited by LIONEL S. BEALE. Vol. IV. (Churchill.)—The most important papers in this number relate to the controversy raised by those who dispute Dr. Beale's statements that nerves never end in free extremities, but always form closed circuits. We have in former numbers expressed our admiration of Dr. Beale's skill as a microscopical manipulator and observer, and we believe that his main positions will be sustained by fair investigation. Those physiologists, however, who employ very inferior methods of preparation, and examine their objects with powers bearing no comparison with his superb lenses by Powell and Lealand, are really not entitled to be heard against him. Before they ask us to attach any importance to their not seeing what he sees, they must put themselves in a condition in which seeing what he describes becomes possible.

ASTRONOMICAL INVESTIGATIONS. THE COSMICAL RELATIONS OF THE LUNAR APSIDES. OCEANIC TIDES. By HENRY F. A. PRATT, M.D. (Churchill.)—We are always desirous that a fair hearing should be given to those who controvert received opinions. The progress of science involves the constant discovery of truths that contradict preconceived ideas, and we all know that submission to authority has been the frequent means of prolonging error. Still, when any one comes forward to deny certain elementary facts which scientific men consider abundantly proved, they cannot expect that students will devote much time to their elaborate arguments, unless they show themselves right with regard to the postulates of the case. Now, Dr. Pratt seems to us, upon insufficient grounds, to deny the correctness of the received opinions concerning the flattening of our globe at the poles, and the ellipsoidal character of its orbit; and we therefore do not feel bound to attempt to follow him in his various hypotheses. The "moon controversy" has brought prominently into notice the fact, that many men of considerable talent and knowledge have not the faculty of appreciating a particular line of argument, just as certain other persons cannot hear particular sounds or see particular colours. With due respect for Dr. Pratt's ingenuity and attainments, we should place him in this category, and should despair of appreciating the grounds of his discordance with all our best mathematicians and physicists.

BACON'S HISTORICAL AND ARCHÆOLOGICAL MAP OF ENGLAND AND WALES, from the Earliest Period to the Present Time. (Bacon and Co.)—We are glad to find this map published at a price which will bring it within the general reach of students. It is coloured so as to show the boundaries of the political divisions of England in Anglo-Saxon and Danish times, and the divisions of Wales before its subjugation. The map is thickly studded with names, and will be a great assistance in realizing incidents of British history.

MALCOLM'S GENEALOGICAL TREE OF THE ROYAL FAMILY OF GREAT

BRITAIN, from the first King of England, the first King of Scotland, and the first Duke of Normandy. (Bacon and Co.)—Though of less substantial use than the preceding, this chart is, by the price affixed, expected to be the most popular. We presume Mr. Malcolm has consulted sufficient authorities for composing his "tree," and have no doubt its exposition of royal marriages and their results will be pleasing to the curious in such subjects.

LIST OF DIATOMACEÆ OCCURRING IN THE NEIGHBOURHOOD OF HULL. By GEORGE NORMAN. (Hull, March, 1865.)—Mr. Norman states that his former list contained about 400 species; the present one contains 480, "a number which considerably exceeds the whole of the species given as British in Smith's work." The present list is not only a proof of the remarkable richness of Hull in objects of this kind, it is also an evidence of extraordinary industry on the part of its author.

JOURNAL OF THE SCOTTISH METEOROLOGICAL SOCIETY. New Series. No. VI. (Blackwood.)—In addition to abstracts of local observations, this number contains essays of importance, among which is a paper by Mr. Alexander Buchan on the storms which occurred in Europe in October, November, and December, 1863. Mr. Buchan says:—"From the rate at which the storms passed over the British Islands a number of them could have been predicted for thirty-six hours at the more easterly British ports, a few for only twenty-four hours, but none for quite so long a period as forty-eight hours. The forms of forty-two different areas of barometric pressure were examined. Of these, thirty were circular, or nearly so, the longer diameter having to the shorter no higher ratio than that of three to two. . . . . The area over which the storms spread themselves was very variable in size, seldom less than 600 miles across, and often two or three times that amount. Occasionally, as the storm area expanded, the central depression divided into two separate depressions, which appeared to become two separate storms, with the wind circling round each.

PROGRESS OF INVENTION.

PALIMPSESTS.—The scarcity of writing materials led, in the middle ages, to an attempt at economising them, which was attended with very mischievous results to literature. Manuscripts containing the most valuable productions of antiquity were effaced, that the parchment on which they were written might be used for some worthless legend, or some fanciful disquisition equally valueless. Various efforts have been made to revive the more ancient writing, in the hope of recovering some lost work of classic antiquity. A very effective means of attaining this object has lately been discovered by accident. An old engraving having been photographed, a line which had been written with a pen was perceived in the copy, though nothing of the kind had been observed in the engraving. An examination, however, showed that it had been there, but was

erased, under the supposition, very probably, that it lessened the value of the engraving. This discovery of another curious result of photography immediately suggested its use as a means of reviving the effaced writing of palimpsests, and it is even hoped that what is thus recovered may be transferred directly to steel or stone.

ECONOMIC SOURCE OF OXYGEN.—Oxygen gas has of late become of considerable importance in the arts, etc., and it is probable that it would be employed for a still greater variety of purposes were it not so dear and difficult to be obtained. These obstacles to its more general use are not likely to exist much longer. It may be very easily and economically procured by acting on sulphate of lime at a high temperature with silex, so as to form silicate of lime, sulphurous acid, and oxygen; and conducting the gaseous mixture into a chamber where it is exposed to a pressure of three atmospheres, which liquefies the sulphurous acid. The oxygen, after having been purified by transmission through lime-water, is compressed into strong receivers. A company has been established at Paris for the production of oxygen in this way, and it is expected that the gas will be furnished so cheaply that it may be employed in the combustion of the ordinary gases for illumination, so as to render their light fifty per cent. cheaper, and at the same time get rid of certain inconveniences which necessarily arise from the mode in which they are burned at present.

NEW METHOD OF ENGRAVING.—The process devised by M. Comte for this purpose consists in coating a plate of zinc with a white water-colour, then drawing the design upon this with a fine point, so as to uncover the surface of the metal, afterwards applying a varnish which adheres to the plate only in those places which have been laid bare by the point, and then washing off the paint with water. The plate is next acted on with nitric acid, which forms hollows between the lines produced by the varnish; and thus there results an engraving *in relief*, from which impressions may be taken in the same way as from wood. This method gives the design actually drawn by the artist, requiring no intermediate hand, which, however skilful, may be incapable of faithfully rendering the intended effect.

CURE OF CONSUMPTION.—Any means of curing this insidious and fatal malady must be hailed as a benefit of no ordinary value to the human race. A remedy which is stated to have this effect was brought before the Academy of Sciences, on the 12th of June. Raw beef or mutton is reduced to a pulp in a mortar, and afterwards passed through a sieve, to separate any tendinous matter. It is then made into balls, which are to be rolled in sugar, or it is merely sweetened with sugar, and administered in spoonfuls, to the amount of from one to three hundred grammes daily. The patient must use as a drink about one hundred grammes of the pulp diffused through five hundred grammes of water sweetened with sugar; also three hundred grammes of sweetened water, to which one hundred grammes of alcohol at 20° Baume have been added, are to be taken

at the rate of one spoonful every hour. The doses and intervals between them must be regulated, to some extent, by the susceptibility of the patient. The raw meat is supposed to have a reconstituent action, and the alcohol a direct effect on the hematose. Persons very far gone in consumption, and some even who could not have survived more than a few hours, are stated to have been completely recovered by this combination of curative agents.

FORMATION OF STEEL BY GASES.—The process of M. Bérard for the formation of steel from cast iron consists in the alternate oxidation and reduction, simultaneously, of different portions of the cast iron. The oxidation is effected by the introduction into the fused metal of atmospheric air; and the reduction, by the introduction of a mixture of hydrogen and carbonic oxide, previously freed from sulphur. After twelve or fifteen minutes the processes are reversed; the portions which had been submitted to oxidation being then submitted to reduction, and *vice versâ*. This alternate action is continued until it is found by testing that good steel has been formed, the last process being invariably that of decarburation. The oxidation changes the metals, whether earthy or proper, into oxides; the reduction brings the iron into a metallic state; and both of them change sulphur, phosphorus, etc., into acids, which escape by the chimney.

NEW APPLICATION OF CENTRIFUGAL FORCE.—The chief peculiarity of Guerin's steam engine consists in the transmission of the steam, after it has done its work in the cylinder, into a fly-wheel, the arms and rim of which are hollow; it is there condensed by a jet of cold water, and the condensed steam and condensing water are expelled by centrifugal force: or the steam is merely driven out by it. In either case the resistance which the waste steam offers to the motion of the piston is supposed to be greatly diminished, the effect thus produced being so much clear gain.

STORAGE OF DANGEROUS SUBSTANCES.—The terrible accidents which have recently arisen from the accidental explosion of gunpowder, and the conflagrations produced by the ignition of petroleum, etc., have caused such serious and well-grounded alarm, that an anxious consideration of the subject could no longer be deferred: and, as a natural result, measures have begun to be adopted which will greatly diminish the danger, and seriously mitigate the consequences of explosion or combustion should they occur. Floating stores have been constructed at St. Ouen, for dangerous substances. They consist of cylinders made of boiler plate, about sixteen feet high and seven in diameter, with convex tops and bottoms, and manholes. They are arranged in rows of twenty-five, are strongly bound together with iron, and are covered down to the water line with planking. They ordinarily lie out in the midst of a spacious basin; and when they are to be loaded or unloaded, are brought to the bank, pumps being used when their contents are liquid.

CASTING OF METAL TUBES, ETC.—A new, ingenious, and very simple way of casting tubes, etc., has been invented by Auguste Larson, a young French workman. The mould is something of the form of a closed cylinder, which, however, is capable of being taken

asunder. The liquid metal is poured into this, while it is revolving with great rapidity; and the centrifugal force causes all the interior details of the mould to be perfectly and sharply filled; so that when the metal has cooled, and the mould is removed, a perfectly undistorted and smooth casting is obtained.

TURBINE BRUSH.—This simple but effective contrivance, which has been lately patented in America, consists of a circular brush, at the back of which is a small turbine wheel, supplied with water through the handle by a flexible tube attached to the latter. The rapid revolution of the brush, aided by the supply of water, causes it to act very effectively, while at the same time a perfect uniformity of wear is secured. This ingenious application of the principle of the turbine is another example of the practical nature of American inventions.

MILLER'S HELIOTROPE.—Professor W. H. Miller, of Trinity College, Cambridge, has communicated to the Cambridge Philosophical Society an account of a new form of heliotrope, intended to reflect the rays of the sun to any desired distant object by means of the hand and eye alone. In its first form the instrument depends upon the property that a ray of light falling in succession upon three plane mirrors at right angles to one another, returns upon a path opposite and parallel to its original course. If the source of light is the sun, its rays, after falling upon three such mirrors, will be returned back again to itself. At any point of their circuit rays will therefore be found going in exactly opposite directions. Professor Miller avails himself of this property to construct a heliotrope by making one mirror of the three the largest. It is coated with chemically precipitated silver, which sends a large quantity of light directly to the distant object desired to be illuminated. The other two mirrors are small pieces of unsilvered glass fastened at one corner of the larger mirror, so that they are at right angles to each other, and make right angles with two sides of the large mirror. When a ray of light falls on the large mirror, and is reflected in one direction, a second ray parallel to the first falls upon one of the small mirrors, by which it is reflected on the second small mirror, and from thence through an aperture in the large mirror in a direction parallel, but opposite to that taken by the first ray. This ray being admitted to the eye of the operator through a hole in the silver coating of the large mirror, enables him to direct the principal beam to any distant object, by hand and eye, at pleasure. Two edges of a rectangular looking-glass, if perfectly square and well polished, produce the same effect as the two small mirrors of unsilvered glass. But a tinted glass, to relieve the eye, must be applied at the back of the looking-glass, where the metallic silvering is scratched away. For the signals of a survey this form of heliotropo will probably supersede all others, from the ease of its construction, its simplicity in use, and from the impossibility of deranging its adjustments. It is made and sold by T. E. Butters, 4, Crescent, Belvedere Road.

SOLUTION OF THE ANILINE DYES.—Hitherto almost all the aniline dyes and their congeners, being insoluble in water, required for solution alcohol or methyline. The former is objectionable on ac-

count of its dearness, the latter on account of its injurious effect on the workpeople; and yet no substitute for them was discovered. M. Gaultier de Claubry has found out a very simple mode of rendering these dyes soluble in water. It may be remarked that their solution is attended with peculiar difficulties, on account of their being, in many instances, composed of constituents of very different solubility. Thus the aniline violet contains red elements which are soluble in various fluids, and blue, which are with difficulty soluble at all. During his researches, M. Claubry ascertained that there are many substances which impart to water the power of dissolving them. Thus gums, mucilages, soaps, glucose, dextrine, the jellies of different feculæ, lichens, and fuci. When, for example, Egyptian soap-wort is used, and it answers extremely well, it may be triturated with the colouring matter. Boiling water is then to be added in successive doses—each being removed before the next is added—as long as anything remains undissolved; the action of the different portions of fluid being aided by shaking, and the clear solutions obtained being removed by decantation. All the solutions must, in the end, be mixed together, as the earlier ones will take up chiefly the more soluble constituents: and thus a perfectly pure tint, quite unchanged by the process, will be obtained. The mode of proceeding may be modified in various ways. Thus, if it is considered desirable to use some alcohol, the soap-wort may be employed first, and the alcohol towards the end of the solution, or *vice versa*.

PORTABLE SUBMARINE LIGHT.—The electric light has very often been used for producing illumination under water; the charcoal points being inclosed in a water-tight receiver, and the battery being placed in a boat, etc. But this arrangement is objectionable; it is very costly, the apparatus is extremely liable to disarrangement, and is difficult to be manipulated; moreover, the light, for many purposes is far too intense. M. Paul Gervais has devised a method of applying an apparatus, very similar to that proposed for use in mines,* to submarine illumination. It consists of a Geisler tube, of an appropriate form, filled with carbonic acid, and inclosed in a stout water-tight glass cylinder, and capable of being put in connection, at pleasure, with a battery and coil, which are within a water-tight case that is easily portable. In constructing this apparatus, M. Gervais obtained the assistance of Ruhmkorff, who is also at present carrying out some improvements, that are expected to render it still more practically useful. The light emitted by it is said very closely to resemble that of phosphorescent animals, except that it is more intense; even when several yards under water it can be perceived at a considerable distance. The instrument used has been kept nine hours at a time under water, and six of these in action; indeed, there does not seem any limit to the time during which it may be in operation.

* INTELLECTUAL OBSERVER, No. xxxviii. p. 146.

IS LIGHT IMPONDERABLE?

WHAT do we mean when we speak of any object around us, and call it a ponderable substance, or one that has weight? Simply that the body in question attracts, and is attracted by the mass of our earth. No doubt it also attracts, and is attracted by, the moon, the sun, and other celestial bodies; but from their great distance their attraction is so much diminished, that we take no account of it in relation to masses of moderate dimensions. The tides result, as we all know, from the attractive force exerted upon the waters of our globe by the sun and moon; and if we could put the Pacific or the Atlantic ocean into a scale, the weight of those fluid masses, or in other words the amount of force with which they pressed towards the earth's centre, would noticeably vary, as it was more or less counteracted by opposing forces exerted by the sun and moon. The weight of bodies on the globe, or on any other planet whose form differs from a true sphere, varies according to its position. Our globe is a little flattened at the poles, and thus any body taken from the equator to either pole approaches a little nearer to the earth's centre, and is more powerfully attracted. The projecting equator, being larger in circumference than a circle near the poles, has to move faster than the latter as the earth rotates, or it would be left behind, which we know is not the case. Now the centrifugal force arising from rotation tends to throw any body off, while the gravitation attraction of the earth tends to pull it towards its centre. Hence the weight of a body, measured by the force with which it tends to the earth's centre, is diminished at any point at which the centrifugal force is increased. Thus two circumstances cause a difference in the weight of bodies moving from the equator to the poles. "Owing to the elliptical form of the earth, alone, and independent of the centrifugal force, its attraction ought to increase the weight of a body in going from the equator to the pole by almost exactly $\frac{1}{590}$th part, which together with $\frac{1}{289}$th due to the centrifugal force, makes up the whole quantity, $\frac{1}{194}$th, observed."*

Weight, then, is simply a result of attraction; and if we desire first to weigh a body at the equator and then at the poles, in order to ascertain the difference, we must obtain an invariable standard of comparison. Counterpoising it with a weight or lump of metal clearly would not do. For, suppose we had one pound of iron as the thing to be weighed, and another pound of iron as the thing to weigh it by, it is obvious

* Sir J. Herschel, *Outlines of Astronomy*, p. 150, seventh edition.

that as they counterbalanced each other at the equator they would do so at the poles, for whatever alteration in weight resulted from their change of place would affect both alike. The tension exerted by a spiral spring affords, as Sir J. Herschel points out, an illustration of a kind of force not affected by change of position; and such an instrument might enable us to compare the attraction of the earth upon a given mass in the two situations described.

These preliminary remarks may help those who have not reflected on the subject to consider weight simply as the result of attraction; and, as our instruments are all comparatively clumsy, it is not right for us to assume that a particular body possesses no weight at all because we have not succeeded in weighing it. If light be a mode of motion of some fluid, that fluid may not, as is commonly supposed, be absolutely imponderable, that is, not at all affected by the earth's attraction. We have, indeed, no right to assume that gravitation is an essential property of *all* matter under *all* conditions. Astronomers trace what we ordinarily *call* the *universality* of this force; but that it is really universal—that is to say, that it exists wherever matter exists—is more than we know. It is common to speak of light, heat, electricity, etc., as "imponderable agents," but we apprehend no thinking man is satisfied with such a phrase. If they are all modes of motion of some kind of matter, either that matter must be ponderable, or gravity only a property manifested under certain conditions.

Mr. Balfour Stewart and Professor Tait consider, in the technical language employed by the former, "that to this time it has been assumed, without proof, that the change in the co-efficient of terrestrial gravity does not in itself alter any other co-efficient of a body; and if a reason be asked none can be given, since gravity is a force of the nature of which men of science are confessedly ignorant."

Now, if gravitation acts upon light so as to have any share in determining the position of any rays emerging from a prism, and forming a spectrum, a considerable change in the position of such a prism and of such light rays, involving a change in the force of gravitation, might cause a dark line in the spectrum to take a new position, more or less differing from that which it first assumed.

When this notion was propounded to Mr. Gassiot, he acted with his accustomed liberality in the cause of science, and requested Mr. Browning to construct a "rigid spectroscope." That is, such a spectroscope that the position of any given line could be exactly measured with minute accuracy, and with the certainty that its position would not be changed by the action of heat, or by the jolting inevitable in transport-

ing the instrument from place to place. The difficulties of making such a spectroscope were very great; but they have been surmounted with marvellous dexterity and skill. A full description of this instrument will be found in the *Proceedings of the Royal Society*, No. 76.

It consists of two prisms of dense flint glass, made by Chance, and having a specific gravity of 3·9. These prisms are mounted on a bed of slate. Light reaches them through a slit, and straight through a *portion* of a right-angled prism, where the refraction is neutralized by a small prism cemented on to it. After passing through the two large prisms, and once suffering refraction and dispersion, it is sent back through them a second time by a third prism, having one side silvered, and thus it is again refracted and dispersed, one set of prisms being compelled to do double work. On its return journey, the light enters the prism over the slit and is reflected to a telescope at right angles to it, and carrying a micrometer. A series of trials in Mr. Browning's workshop, at Kew, and in the apartments of the Royal Society, have shown that the variation of the D line is quite infinitesimal, in spite of great changes of temperature and motion from place to place.

It was at first intended to send a "rigid spectroscope" up in a balloon; but the weight of the present form, and the uncertainty in balloon experiments of the prisms acquiring a uniform temperature, caused this idea to be abandoned, and Mr. Gassiot invites the Royal Society to request Her Majesty's Government to send the instrument on board some ship sailing between points on the earth's surface differing considerably in latitude, and, consequently, in the force of terrestrial gravitation. Should such experiments succeed, light must no longer be considered as the motion of an imponderable substance. Should they fail, it may still be held that success would be possible, if stations much nearer to, and much remoter from, the earth's centre, could be reached.

We must not be understood as stating that the contemplated experiments are attempts to *weigh* light; but if it can be proved that any change in the direction and force of gravitation affects the position of any line in the rigid spectroscope, the ponderability of that fluid of which light is a mode of motion might be probably assumed. Is gravitation merely a mode of force, correlative with other forces known and unknown?

ARCHÆOLOGIA.

MR. J. T. BLIGHT, a zealous and careful antiquary, and very clever artist and engraver, of Penzance, has contributed to the July number of the *Gentleman's Magazine* an excellent though short paper on CORNISH BARROWS. The barrows to which Mr. Blight directs attention in this essay are of a peculiar class, large tumuli, containing at least one rather extensive chamber, and sometimes several smaller ones, formed of massive stones, and they are found chiefly in the West of England, in the Scilly Islands, in the Channel Islands, and in Brittany. Our own impression is that these tumuli are not of an extreme antiquity—they do not belong to a very barbarous population, but to one which has made advance in social progress, and has attained to about the social condition of the Anglo-Saxons, a little before they entered Britain, or of the Icelanders in the time of Burnt Njal. They belong probably to the Britons of the South-West, from no very remote period before the Roman period to some time after the establishment of the Roman power, and were the burial-places of the patriarchal heads of families of importance, where, probably, generation after generation was interred. Such barrows are not found in the central and then more barbarous parts of the island, because they were held by the older populations, while these districts had received an immigration of more civilized peoples. In Scilly they are called giants' graves—a common popular name for anything ancient. In its simplest form, the receptacle of the dead in these tumuli is a mere square chamber, an expansion of the idea of the ruder cromlech, though more elaborately built; in its more enlarged character it took the form of a great subterranean gallery, as at Bolleit and Pendeen, in Cornwall. The chamber of the barrow at Pennance, in the parish of Zennor, described by Mr. Blight, is nine feet six inches in length, by four feet in width, and four feet four inches high. It is constructed in that bold sort of Cyclopean masonry which has prevailed in Cornwall down to the present day, the more massive stones forming the basement of the walls. That of the end of the chamber is formed almost entirely of one single slab. The roof consists of large slabs of granite thrown horizontally across from wall to wall. This chamber lay in a direction from north-west to south-east, the entrance being from the north-eastern end, where there was no wall, and access was easily obtained by clearing away a part of the side of the mound. This mound is twenty-three feet in diameter, and eight feet in height. It is bounded by a circle of retaining stones, some of them of large dimensions, and is filled up with stones chiefly, mixed with some earth, piled around and over the cell. No remains were found in the chamber, or cell, of this barrow, which has been the case with others of the same class, probably in consequence of the depredations of people who, at some perhaps remote period, opened them in search of treasure. Mr. Blight describes the opening, at which he assisted, of two other Cornish barrows, on Conquer

Down, in the parish of Towednack, both composed of stones—cairns, in fact—and bounded by a circle of larger stones. One was forty-five feet in diameter, and six feet in height, and covered only one interment, consisting of a very rude urn, containing the ashes of the dead; it had been placed exactly in the centre—which was placed with the mouth downwards, on a large slab of granite, and was protected by another slab of granite placed over it. It was the common practice in these barrows, which antiquaries have called British, to place the urn with the mouth downwards. The urn, which is preserved not quite entire, is of the usual character found in this class of barrows, but of a form not very common, being not quite perfectly barrel-shaped. It is of coarse clay, of a light greyish brown colour, and has been sun-dried; it is ornamented round the upper rim with four lines of dotting, and the well-known zigzag pattern deeply impressed between them. The other barrow was smaller, for it measured thirty-six feet in diameter, and only four feet in height; but it was of the same form and materials. There was no urn, or regular interment, but in the centre were found traces of burning, some bones of animals, and the half of a flint pebble, which had been artificially broken.

At a recent meeting of the Ethnological Society (June 7th), the Swedish Professor Nilsson communicated a paper on STONEHENGE, which excited some interest. His theory is that this remarkable monument of antiquity belongs to the bronze period, a bronze period of his own (Professor Nilsson has published a book on it), which he regards as having been introduced by the Phœnicians, and he supposed the date of Stonehenge to be about four thousand years before Christ. According to the doctrines of this school of antiquaries, the Phœnicians had established themselves not only in every part of Britain, but even in the remotest parts of Scandinavia, and they must have formed a very important part of the population. Professor Nilsson ascribes to these Phœnicians New Grange, in Ireland, and similar monuments, as well as the monuments known as cromlechs, Druidical circles, etc., wherever they are found in the British islands. In this paper, Professor Nilsson shows an extraordinary want of critical appreciation of facts and arguments, for he assumes that a certain supposed Phœnician inscription found in Scotland, and exhibited at the Cambridge meeting of the British Association, where the blunder about it was satisfactorily exposed, is still a genuine monument of the Phœnician occupation of Britain. It is a very remarkable circumstance that this presumed presence of the Phœnicians in Britain rests upon no foundation whatever—that no ancient writer known to us has ever said that they were here, and that no ancient monument points to their presence here. The very writer who has been quoted in proof of the visits of the Phœnicians to Britain, Strabo, says just the contrary, for he makes the Cassiterides, the island from which he pretends that the Phœnicians obtained their tin, a different place from Britain, and more distant from the continent of Europe, and that the opinion which identifies them with the Scilly Islands is a mere blundering guess is evident, for the

Scilly Islands are not few in number, like the Cassiterides, and no tin was ever found in them. According to Diodorus Siculus, who wrote at the same time as Strabo, that is, about half a century before Christ, the tin of Britain was carried to the Mediterranean through Gaul, and perhaps the Cassiterides islands was a name without any truth—a fiction of the Carthaginians, to conceal their commerce in tin along the coasts of Spain and Portugal, if the story of the ship being watched by the Romans and voluntarily wrecked, be not itself a mere legend. It would, indeed, be strange, if our islands had been so much frequented by the Phœnicians, that Diodorus, proverbial for his careful research and great historical knowledge, Julius Cæsar, who was especially interested in the metallic produce of Britain, and Tacitus, who had inquired particularly into the ethnological history of our island, should never have heard of them. It is our belief that the Phœnicians were never in Britain. The facts probably are that the tin mines of Cornwall were opened by settlers from Gaul, and perhaps from Spain, and that the Phœnicians had obtained tin in these countries, and monopolized the trading before it was carried over to Marseilles.

With regard to CROMLECHS and DRUIDICAL CIRCLES, which Professor Nilsson ascribes to Phœnician workmanship, there are circumstances which seem to show that they are by no means necessarily of the extreme antiquity which some people would give to them; and we would call attention to one record especially, which, we believe, has not been noticed by antiquaries. Among the ecclesiastical laws of the Anglo-Saxons, there is one code entitled "The Laws of the Northumbrian Priests," which appears to belong to the ninth or tenth century (*after* Christ), and which contains some provisions against practises of Paganism then existing. One of these laws forbids people making a frith-geard round a tree, or a stone, or a fountain, all which three we know were objects of superstitious worship among the Anglo-Saxons. The words of the original, literally translated, are, "If there be a frith-geard on any one's land, about a stone, or a tree, or a fountain, or any folly of that kind, then let him who made it pay the penalty of the breach of law." The word frith-geard, literally peace-yard, means simply a sacred inclosure, exactly such as was contained within that circle of stones which has been so often called Druidical, for a circle is the natural form of a small inclosure of space. The circle round the sepulchral tumulus marked the space belonging to the dead, within which nobody was allowed to trespass irreverently; the circle round the object of worship limited the space into which none but the priest was admitted. We look upon this law as showing not only that the circles of stones did not always belong necessarily to sepulchral interments, but that the construction of them was continued to so late a period as that of the compilation of these laws. Trees, to have become an object of worship, were probably ancient at the time the circles were raised round them, and have necessarily decayed and perished long ago, and accordingly we not unfrequently find circles of stones with no object remaining in the interior; circles of stones, with a single

upright stone in the centre, are not at all uncommon; and we have ourselves seen in North Wales a fountain which had a "Druidical circle" round it. This curious law, therefore, assures us that it would be very unsafe to assume that all circles of stones have belonged to sepulchral monuments, or that they are prehistoric in date, or even older than Saxon times. This must have some weight even on the question of the antiquity of Stonehenge, the only objects met with in which that have characteristics of date are fragments of pottery found under two of the large upright stones on their fall, and stated to have been distinctly Roman. It must be borne in mind that "Roman" in our Western antiquities means objects belonging to the Roman period, and continuing in use during several subsequent generations.

To return to the subject of CROMLECHS, it may be well to remark that, in the new number of the *Archæologia Cambrensis*, Mr. Blight, of whom we have spoken above, has given an account, with engravings, of a very curious monument of this description, standing at Llansantffraid, near Conway. It consists of a rather fine specimen of the ordinary cromlech, an immense block of stone, calculated to weigh nearly twenty-five tons, supported on what appears to have been originally about a dozen upright stones, forming the walls of a chamber, measuring eight feet from east to west, by seven from north to south, and averaging about three feet and a-half in height, so that its dimensions were not much different from the more elaborately-built chamber in the Cornish barrow at Pennance. But the peculiarity of this cromlech consists in two upright stones, raised on the outside on more elevated ground (for it stands on the side of a bank), which had evidently been placed there symmetrically for some purpose at which we cannot now even guess. A stone lying flat on the ground a little further off appears to be all that remains of a circle which inclosed the sacred ground of the cromlech, and probably formed the basis of a mound. This communication from Mr. Blight is followed by a paper on cromlechs in Pembrokeshire, written by the Rev. H. Longueville Jones, the founder of the Cambrian Archæological Association, long one of its most zealous and enlightened supporters, and the editor of its journal. Mr. Jones has given a description, with engravings, of four very remarkable cromlechs at Newton, Manorbeer, St. David's Head, and Pentre Ifan, all well worthy of a visit from the numerous excursionists who now turn their steps to South Wales. They are all remarkable for the size and weight of the flat stone which covers them. In the first of those we have mentioned, that of Newton, the supporting stones at one end have fallen, and the cap-stone remains with one end upon the ground. At St. David's Head, the cromlech stands outside of an ancient camp, or entrenched work, and the circle of stones remains which once defined the limits of the covering mound. That at Pentre Ifan is one of the largest cromlechs in Wales. When it was visited by the Cambrian Archæological Association in 1859, five persons on horseback stood within it, and under the capstone, at the same time. In this instance the existing cromlech seems to have formed one of several sepul-

chral chambers, once covered by a common mound, as traces of the others are found around it. It has been suggested to excavate in the interior of these monuments, but it may be doubted if this would lead to discoveries of any importance, for, whatever were the remains interred in it, they were, no doubt, laid on the floor at its present level, and were swept away when it was uncovered and opened by ignorant people who could not appreciate them.

It is sometimes necessary, in the interests of science, to repeat the simple explanation of words which people persist in misunderstanding. Such is the case with the word CELT, applied, not very properly, to an ancient implement in bronze or stone. Writers on what is called prehistoric archæology are constantly using this word, under the impression, apparently, that it has some special relation to these implements, and also to the people to whom they have been ascribed, and some even go so far as to call them *kelts*, as in a recently published work now before us. The facts of the case are these:—In the year 1709, Ralph Thoresby, the Yorkshire antiquary, communicated to the equally well-known antiquary, the dull, but industrious and painstaking writer, Thomas Hearne, some examples of these implements in bronze. Now Hearne found a word, *celtis*, of late or merely technical Latinity (it is not found in the dictionaries of pure Latin), signifying a chisel, or some tool of that kind, and he wrote a dissertation, printed in the first volume of his edition of *Leland's Itinerary*, to prove that these peculiarly-formed bronze implements were the *celtes*, or chisels, of the Romans. Antiquaries during the last century appear to have agreed quietly in this interpretation, and the name *celt* has thus been unwisely adopted for the bronze implements, and very absurdly transferred to implements in stone. In fact, Thomas Hearne was probably quite wrong. The Roman *celtis* appears to have been an instrument for cutting inscriptions. Ducange explains the word as meaning *celum sculptorum*, and quotes an ancient inscription found in Rome, which describes the stone on which it was written as being the work of the mallet and *celtis*—

"MALLEOLO ET CELTE LITTERATUS CILEX."

The instruments to which our antiquaries have given the name of *celts* were certainly not made for engraving inscriptions in flint. It is clear that the word is wrongly applied, and ought to be abandoned.

We are now approaching the season when archæological and other societies hold their ANNUAL MEETINGS, or CONGRESSES, in the country, and we may look for new contributions to our archæological knowledge. The British Archæological Association will meet in the city of Durham, under the presidency of the Duke of Cleveland. The meeting will commence on the 20th of August. The Archæological Institute proposes to hold its meeting at Dorchester, on the 1st of August, under the presidency of the Marquis Camden. The Cambrian Archæological Association will hold its meeting this year at Douglas, in the Isle of Man, beginning with the 21st of August.

T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ANTHROPOLOGICAL SOCIETY.—*June* 6.

THE RACES OF ESKIMO LAND.—Dr. Berthold Seemann, in a paper on our knowledge of the races of the Arctic region, remarked on the desirability of extending our information with regard to their geographical range, as the question has still to be answered how near to the North Pole have human beings taken up their abode? The Eskimo, who are the most Arctic people known, are also one of the most widely-spread races on the globe; they extend from Greenland to the Aleutian Islands, living almost entirely on the produce of the chase, and clothing themselves with the furs of the wild animals they have slain. The personal experience of the author leads him to regard the western Eskimos as far superior to those of the eastern district, a difference that he traces to the low summer temperature of the eastern side of the most northern part of America. This produces a stunted vegetation, and consequent poverty of animal life; hence there is a more precarious and irregular supply of food, and consequently both the physical and mental development of the human races are arrested. Dr. Seemann described the Eskimo as generally destitute of any religion; they believe in the existence of good and evil spirits who inhabit the earth, sea, and air, but place them all on a footing of equality. Their marriage customs are very singular. When a man has made choice of the girl he wishes to marry, he proceeds to her mother, and asks for her hand; if the mother is satisfied that he can support a wife by his pursuit of hunting and fishing, she gives her consent, when the bridegroom obtains a complete suit of clothing, and offers it to the bride, who takes it to her home, and on returning to the bridegroom dressed in it, is considered as his wife. Infidelity is very rare, but polyandry exists to some extent, apparently among the less wealthy individuals.

GEOGRAPHICAL SOCIETY.—*June* 12.

VISIT TO THE WAHABEE CAPITAL OF ARABIA.—Colonel Lewis Pelly, political resident at Bushire, described his recent journey to the Wahabee territory, in company with Dr. Colvill and Lieutenant Dawes. They started on the 18th of February, and entered the country at the Port of Kowait, in the north-west corner of the Persian Gulf, and proceeded in a S.S.W. direction over the desolate unpeopled waste which separates the coast settlements from the well-peopled and cultivated highlands, or *Nejed*, of Central Arabia. The party did not attempt to conceal their nationality, although they found it prudent to throw the *abbah* and *chiffeeah* of the country over their own clothing. They travelled on camels, starting each morn-

ing a little before daybreak, and continuing the march until sunset. Their astronomical observations were taken at night, when the Arab attendants were asleep; and for this purpose they planted their tent with the entrance open to the North star. Soon after leaving Kowait all traces of road cease, and the Wahabee territory commences with boundless, gently-undulating plains, which in this early spring-time were slightly sprinkled with grass and flowers. Snakes, lizards, and insects abounded, but no human habitation was seen until they reached *Nejed* Proper, and only a single tree and one group of wells. The physical character of the country was varied by a series of seven ridges of sand hills, which lay parallel to each other and to the shore-line of the Persian Gulf, and which the party again crossed when returning by another route. They extend over many degrees of latitude, and are separated by narrow valleys; but there is, independently of this, a gradual general rise of the country from the seaboard towards the north-west. After ten days' march across these sandy ridges and narrow valleys, the party saw before them a boundless plain called Ormah, sprinkled here and there with brushwood. Wells and running streams were met with, but the latter soon terminate in the arid country to the east and west. The Ormah district is bounded on the west by a remarkable ridge, through a picturesque gap in which the road leads into Shaab, an upland plain a few miles in width, bounded by the Aridh hills, which are succeeded on the north by the Towaij chain, the two being separated by the well-peopled plain of Mehmeel. The cultivated and populous district of Sedeyr is a strip of land lying immediately under the Towaij range. The first town they entered in the centre table land was Sidoos, a cheerful, neat-looking place, embosomed in date-groves, where they were well received and invited to turn Mussulmen. They then turned eastward towards Riadh, the Wahabee capital, arriving fifteen days after their departure from Kowait. Colonel Pelly had three interviews with the Amir or Wahabee ruler, who is both the spiritual and temporal head of the Wahabee territories, and in all respects absolute throughout his dominions. The Amir was a man of exceeding dignity and self-confidence. He treated the British Envoy throughout with respect, and explained that the Wahabee empire was cut off, by the physical character of the country, from external relations; consequently he could have no foreign relations, nor did he wish for any, especially with the English. He claimed for the Wahabees the credit of having saved the Mahommedan religion from falling off from its original purity, and proposed to Colonel Pelly that he should become a Mahommedan. As far as the chief himself was concerned, Colonel Pelly believed that no obstacle would be placed in the way of a scientific exploration of the country, but the persons who surround him would be likely to present the greatest difficulties, on account of their intense bigotry and hatred of foreigners. The party returned to Okair, on the shores of the Persian Gulf, by way of El Ahsa district, a fertile oasis, from 20 to 30 miles in length by 12 in width. The longitude of Riadh is 46° 41′ 48″, the latitude 24° 38′ 34″.

NOTES AND MEMORANDA.

A Water Barometer in a Thunderstorm.—The following description of the action of a water barometer during a terrific thunderstorm at Birmingham, on July 8th, is by Mr. Alfred Bird, of that town. The fall of rain was unprecedented, and a storm of thunder and lightning raged from 1h. to 3h. p.m., which sacrificed one life in Birmingham, besides doing much damage to property at Balsall Heath, Wednesfield Heath, Wolverhampton, and other places:—"Mr. A. Bird, of Worcester Street, has a water barometer fixed upon his premises, and the action of the storm upon it was of a most remarkable description. In a barometer of this kind the water rises 13½ inches for every inch on the ordinary mercurial barometer, and the action is, therefore, most distinct. When the storm commenced the column of water stood at 389 inches, which would be equal to 29½ on the ordinary barometer. As the storm progressed, the oscillations in the water were from half an inch to an inch, and at nine o'clock in the evening, the barometer stood at 391½, and was then steadily rising. At every flash of lightning there was an instantaneous fall of the column of water from a quarter to half an inch, and then a gradual rise as the rain came on. The movements were remarkably interesting. When the electric disturbance had ceased, the column of water gradually rose, indicating that the density of the atmosphere was steadily increasing. This water barometer is, we believe, the only one in existence in the county at present." The instantaneous fall of the column of water from a quarter to half an inch at every flash of lightning is remarkable, corresponding apparently to sudden jumps of an electrometer, observed in thunderstorms. The column of fluid in a barometer is balanced as delicately as the gold leaves in a gold leaf electrometer. Being attracted by the free electricity in the atmosphere, it is not impossible that it might oscillate in a similar manner. At every flash of lightning a certain quantity of free electricity suddenly disappears, and the column of water is instantaneously let fall. If this be a true explanation of the phenomenon, the water barometer, in which the movements are greatly magnified, is at one and the same time a barometer and an electrometer. The distinctive character of the storm illustrates the great increase of electric tension with the magnitude of the fall of rain. The rain-fall in this instance amounted to 1·53 inch in two hours, a quantity only common between the tropics, and fortunately of very rare occurrence in our latitudes. A particular form of aneroid by Mr. Browning, described in Intellectual Observer, vol. vi., p. 38, would, as pointed out by us, probably be the most convenient instrument for testing these questions. We should much like to see one of these instruments suitably placed.

Comparative Luminosity of Venus and the Moon.—M. Chacornac has been able to carry out in the neighbourhood of Lyons a plan of measuring the relative intensity of the light reflected by equal surfaces of Venus and the moon. He employs an apparatus for double refraction and polarization, to which we have before alluded, and his experiments were made on the 20th June, at three a.m., when Venus and the moon were in conjunction. With a magnification of 70, the extraordinary image of Venus was visible in all its outlines, when only one two-thousandth of its light was permitted to reach the eye. Under these circumstances the dimensions of the planet were noticeably diminished, as M. Chacornac had previously found with reference to Jupiter. A brilliant portion of the moon, between the craters Rocca and Eichstadt, S.E. of Grimaldi, was selected for comparison, and it was found that the greatest reflecting power of the moon was only a tenth of that possessed by Venus. M. Chacornac could not detect any trace of polarized light in Venus, though it is very noticeable in the moon, and he considers that the light we receive from Venus is reflected from a continuous surface of clouds, and that the spots seen on her disc was not permanent, as De Vico supposed.

Sun Spots and Jupiter Spots.—M. Chacornac has kindly sent us engravings of equatoreal spots seen on Jupiter at half-past eight and half-past nine p.m., October 13th, 1856, in order to show their resemblance to sun spots (also engraved) seen at

noon on October 24th, 1864. The Jupiter spots are arranged conformably with the equatoreal winds of that planet, and the sun spots appear in like manner influenced by the rotation of that luminary. We have in a former number given an account of M. Chacornac's views regarding the sun spots as indications of eruptive action, and he thinks the Jupiter spot of October 13 "the probable result of a jet of vapour from a volcano reaching up into the region of clouds."

Airey on a Polar Expedition.—The Astronomer Royal writes a letter to the President of the Geographical Society, proposing that the new expedition should be towards the South Pole instead of the North. He points out the importance of observing the transit of Venus in 1882 from a good southern station, and recommends a previous investigation of the coast between Sabrina Land and Repulse Bay. So eminent an authority as the Astronomer Royal ought to be favourably listened to by the Government, and the information which he desires should be obtained; but we cannot see the slightest reason for putting the projects in competition. For geographical and other purposes no approximation towards the South Pole could possibly diminish the desirability of reaching the North Pole. As Mr. Markham showed in the excellent paper we recently published, the expense and risk of such expeditions are both trifling, and for a country that is in the habit of flinging away millions in experimenting, often rashly, with ships and guns, to refuse fifty thousand pounds for a couple of scientific expeditions is neither wise nor truly economical.

A New Anemone.—Mr. Gosse describes in the *Annals of Natural History* a new anemone, the *Ægeon Alfordi*, discovered by the Rev. D. P. Alford, M.A., Chaplain of the Scilly Isles. It has a red basal disc and pea-green column, suffused with purple, and the whole covered with red dots so minute as to be distinguished only by the aid of a lens." The column of the genus *Ægeon*, formed by Mr. Gosse to receive its one known species, the *Æ. Alfordi*, is "longitudinally fluted, as if composed of a multitude of slender vertical cylinders placed side by side. Each cylinder studded with a single vertical row of minute warts. No suckers or loop-holes. The tentacles are numerous in several rows, and scarcely retractile, those of *Æ. Alfordi* being of a lustrous green, each bearing a faint line of grey along its outer side. When fully expanded it is sometimes 4 inches in height by 1½ in diameter. At other times it will be 2 inches in each direction. Expanse of flower 6½ inches. It possesses a wonderful tenacity of life, and does well in an aquarium." Mr. Gosse's specimen was sent to him by post on the 4th of April. On the 12th he received notice from the post-office that it could not leave Plymouth till repacked, as sea-water was exuding from the tin case. This was accomplished, but the creature did not reach Mr. Gosse till the 17th, and then manifested its vitality by soon adhering and expanding in all its beauty.

Lawson on the Optical Adjustment of the Eye.—Dr. Lawson publishes a very important paper in the *Ophthalmic Review*, No. 5, on the accommodation power of the eye. He controverts the theory commonly adopted (without proof), on the authority of Helmholz and others, that the crystalline lens is rendered more convex for near vision, and less so for distant vision. Dr. Lawson points to the absence of any anatomical evidence that such action can take place, and he disputes the conclusiveness of certain optical experiments from which it has been assumed. A careful examination of the eye of an emu convinced Dr. Lawson that the ciliary muscle had no attachment to the ciliary processes or to the lens, and he observed that the ciliary muscle was so placed that its contraction must alter the form of the cornea. He argues that if such a mode of focussing the eye is provided in the case of the emu, it is probably so with man. Dr. Lawson further contends that the experiments of Helmholz are consistent with his theory of the action of the eye. The subject is too technical for us to pursue it at length, but we think Dr. Lawson invalidates the opinions that have been usually received, and he substitutes an explanation so probable as to deserve the most careful and candid investigation.

Artificial Fecundation of Grain Crops.—In a former number we gave an account of M. Hooibrenck's plan of artificially distributing the pollen of grain crops by sweeping over them when in flower strings having tufts of wool attached

to them. M. Camille Schnaiter details in *Cosmos* some fresh experiments, in which the gain of this process appeared to be about 15 per cent. Repeated trials are, however, necessary in such a case.

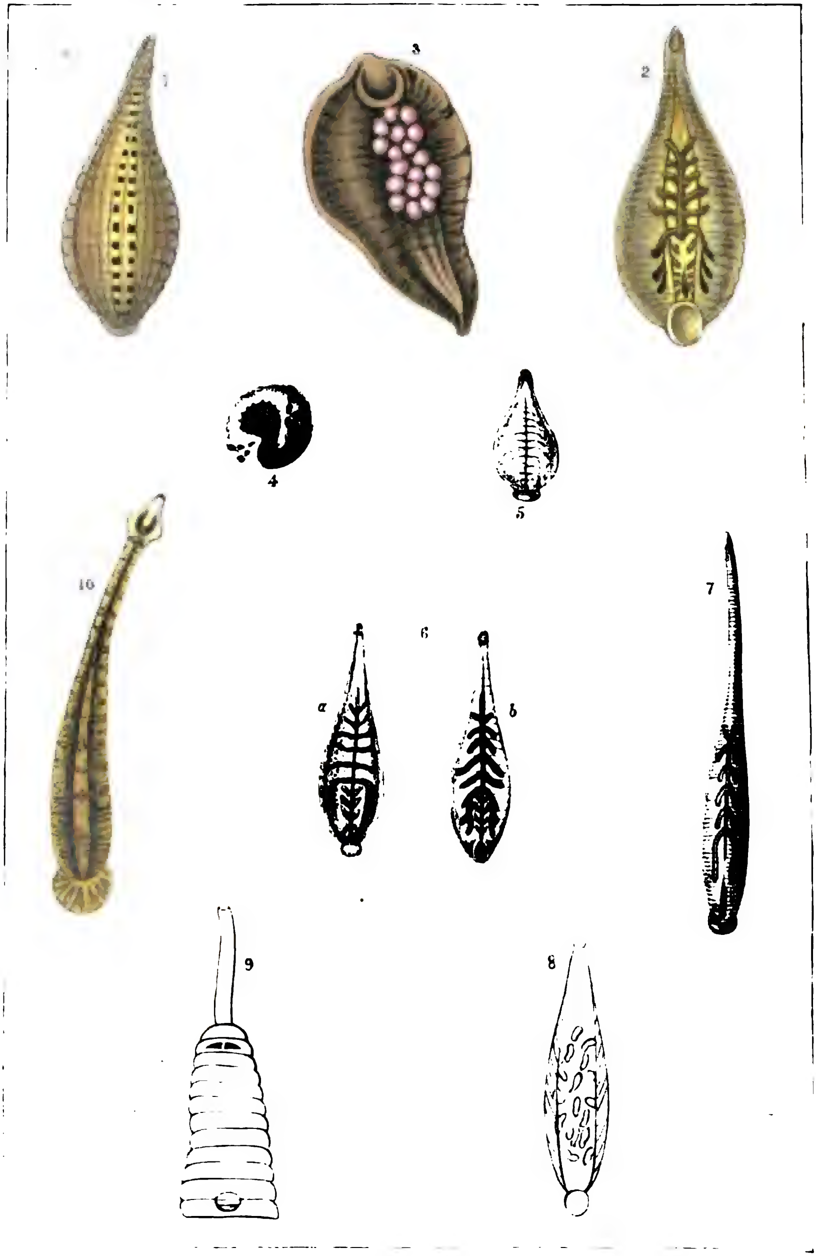
Remarkable Thunderstorm in France.—M. Camille Flammarion states in *Cosmos* that on the 8th of June at Huy (Meuse), a shepherd and his flock were struck by lightning. Out of 152 sheep 142 were killed, and the sheepdog could not be found. The lightning fell like a rain of fire over a space of more than 15 mètres.

Gas Works and Respiratory Disorders.—We mentioned in a former number that a French physician recommended whooping-cough patients to inhale the exhalations of the purifiers in gas-works. A commission now reports to the French Academy that the medicative action may be obtained by placing 60 or 70 grammes of the "brown ammonia," obtained from gas works, on a plate, and allowing it to evaporate in the chamber of the patient. They report it as useful in many respiratory disorders.

New Patent Bubble Blower.—Three years ago, when the subject was quite new, we gave an account of Plateau's films and bubbles (see vol. i., p. 309). Messrs Myers, of Berners Street, have now imported a neat little apparatus, adapted to blowing the large and comparatively permanent bubbles which were so much admired for their magnificent colours when first exhibited in this country by Dr. Frankland. A globular tin vessel is partly filled with the soap compound—oleate of soda and glycerine—described in the notice above alluded to. By pressing the thumb upon an India-rubber valve closing the mouth of this vessel a sufficient quantity of the compound is thrown up into a little cup, below which a flexible tube enters. On blowing steadily through the tube, a fine bubble may be formed, and detached with facility. This apparatus is neater and easier to manage than a tobacco pipe, and if Messrs Myers sell the soap compound properly prepared, they will no doubt popularize M. Plateau's beautiful experiments.

Collins's Dissecting Microscope.—Mr. Collins has made for Dr. Lawson a very convenient dissecting microscope. It consists of a small neat mahogany box carrying dissecting instruments, and having, instead of an ordinary stage, a gutta-percha trough to which the object to be dissected can, when necessary, be pinned, and covered with water. When transparent illumination is required, the object can be brought over a glass disc let into the trough, and placed over an adjustible mirror, by which light from a natural or artificial source can be thrown up. The magnifiers are binocular and fitted to a sliding adjustment. Dr. Lawson finds that when both eyes are employed, and the object well-illuminated, very small parts can be dissected with a slight magnifying power, and in the present apparatus two convenient wrist supports draw out, one on each side. This form of instrument is excellently adapted to the average wants of students, and amateur preparers of microscopic objects. It would also do well for botanical investigations.

Improved Warrington's Microscope.—Mr. Collins has improved the admirable portable microscope devised by Mr. Warrington, by converting the lid of a small oblong mahogany box into the stand, and giving two grooves for the stage to be fixed in, so as to be in its right position at different angles to which the instrument may be inclined. Mr. Collins has also made an addition that will be exceedingly welcome to possessors of aquaria and large glass cells. He fixes the Warrington microscope to the glass by means of a pneumatic holder, which is instantly attached or detached. Thus fixed, and furnished with a two or a four inch power, the habits and proceedings of the inhabitants of glass tanks or cells can be very conveniently watched. Every possessor of an aquarium should have a microscope of this sort. The object-glasses having the universal screw will work with any other microscope, and the Warrington microscope in its present form is by no means expensive.



SNAIL LEECHES

Glossiphonidæ.

1-4. Glossiphonia complanata. 7-[illegible] Glossiphonia [illegible]
5-6. G. [illegible] [illegible] G. [illegible]

THE INTELLECTUAL OBSERVER.

SEPTEMBER, 1865.

"SNAIL-LEECHES," WITH A MONOGRAPH OF THE BRITISH SPECIES.

BY THE REV. W. HOUGHTON, M.A., F.L.S.

(*With Two Plates.*)

There are many objects familiar to the eye of the aquarian naturalist with which, however, he may be almost entirely unacquainted, so far as relates to their habits and structure. It is impossible to turn up a number of small stones in a brook, or to examine many aquatic plants and submerged pieces of wood, without discovering specimens of animal life, which, perhaps, from their not very prepossessing appearance, we are almost disposed to neglect. We are greatly delighted should we meet with a piece of water-weed to which are attached numerous *Melicertæ*, and should our pocket-lens reveal the presence of a few colonies of *Stephanoceros*, we are almost wild with delight, but the writhing horse-leech and *Nephelis* we are inclined to look upon with no pleasurable feelings, and should decidedly object to the introduction of such nasty, slimy creatures to the other tenants of our aquarium. And yet the graceful method in which many leeches swim is well worthy our admiration, while the study of their anatomy will amply repay any amount of patience bestowed upon it. The different species of snail-leech, to which I am now introducing my readers, do not generally present externally any very captivating appearance, and yet they are objects of especial interest to the naturalist, from the circumstance that some of this family do literally deposit their eggs upon the underside of stones and leaves, and sit upon them until they are hatched. Again, from the great transparency of the young ones, it is, comparatively speaking, an easy task to make out a good deal of the structure and internal anatomy, while the facility with

which specimens may be obtained renders continuous investigations easy.

The snail-leeches are properly separated from the true red-blooded leeches, such as *Hirudo medicinalis*, *Hæmopis sanguisuga* (horse-leech), *Nephelis* (whose oval capsules with their contained eggs are common at this time of the year on every aquatic plant), *Trochetia* and *Aulastoma*, which form the family of *Hirudinacea* (see Grube's *Die Familien der Anneliden*, Berlin, 1851). The snail-leeches, which have colourless blood, and differ in several important particulars from the true leeches, form, with the genus *Piscicola*,* a distinct family, to which, from their possessing a peculiar characteristic proboscis capable of exsertion, the appropriate name of *Glossiphonidæ* (syphon-tongued) was proposed by Dr. Rawlins Johnson in 1816. Before the researches of Dr. R. Johnson, the Glossiphons were classed promiscuously with various other leech-like animals, to which the generic name of *Hirudo* was given. This appropriate term has been unfortunately allowed to give place to that of *Clepsine*, proposed, I believe, by Savigny in 1827. What the derivation of the word may be I am unable to discover.

The snail-leeches inhabit fresh water, and no marine species have as yet been found. In every brook, in every pond, and almost in every ditch, certain species occur. As a rule pure water is preferred, but *Glossiphonia bioculata* and *G. hyalina* are by no means particular in this respect. The normal form of a snail-leech when at rest may be described as follows:—Body dilated and depressed; upper surface more or less convex; the under surface is flat and concave; the anterior extremity, which in a few species may be said to form a distinct head, is always less obtuse than the anterior; the mouth, which is situated nearly at the apex of the anterior extremity, is transversely elliptical, two-lipped, and furnished with a strong muscular protractile proboscis; eyes variable, according to the species, there being either one, two, three, or four pairs, generally of a black or deep claret colour, disposed in two longitudinal series, but slightly converging towards the anterior extremity; in some individuals the anterior pair are wanting, and the order of arrangement is confused. The hind sucker is always much larger than the front one; indeed, the mouth, forming the anterior sucker or *acetabulum*, is no true sucker at all.† The colour of the different species, as well as the consistency of the body, varies; some are grey with rows of dull spots, others minutely speckled, others marked with golden dots; some are

* I include *Piscicola* with the Glossiphons on the authority of Grube, who recognizes a proboscis in that genus, but I am not satisfied that *Piscicola* is possessed of this organ.

† *Piscicola*, however, has the anterior sucker fully developed.

semi-crustaceous, and one species soft and flabby; some of the species when taken out of the water roll themselves up oniscus-like (Pl. 1, Fig. 4), while one has the habit of putting out its tongue or syphon when handled (Fig. 9). These creatures live upon the juices of various aquatic animals, such as small worms, gnat-larvæ, and molluscs. The proboscis is inserted into the body of the victim, and the nourishing liquid pumped out. All the species are oviparous, depositing their ova upon submerged bodies, and sedulously incubating them, as in *G. complanata*, *marginata*, and *tessellata*, or else they carry them about within the cavity of the abdomen, formed by the folding inwards of the margins, as occurs in *G. bioculata* and *hyalina*. Observers having noticed the young completely closed in by the folds of the abdomen, have erroneously described certain kinds as viviparous. The whole family is oviparous. The curious incubating habit already mentioned appears to have been first noticed by Baker, who, I think, observes that the young frequently leave their mother's pouch and return again to their shelter. I have not witnessed this latter circumstance. None of the family are capable of swimming, so far as I have observed; all the members locomote by attaching one extremity of the body to the ground or the surface of leaves, etc., and by drawing the other extremity up to that point. The closely allied genus, *Piscicola*, common as a parasite on fish, both swims and moves in the manner above described.

Having made these general observations, let us glance at some of the parts belonging to the internal structure of these creatures. The species *G. complanata* is perhaps as good as any to operate upon. Having put our subject under the influence of chloroform, we place him in a small shallow trough of fresh water, and by means of a couple of pins, one at either extremity, fasten him down on his back. The form of the mouth is readily seen under the lens; with a little skilful manipulation, we shall see that the mouth is connected with the characteristic proboscis by means of a delicate membranous œsophagus, with which it is continuous, and by which it is included: when the animal protrudes this tube the membrane is drawn over it, like the unfolding of a glove from the finger. In form this tube is cylindrical, minutely segmented at the apex, and sometimes bulbous at the extremity (Pl. 2, Fig. 2); its reticulated muscular structure is seen in Fig. 3. The juices which constitute the food of the snail-leech proceed down this tubular organ (which is protruded at the time it is feeding, and which is fixed in the soft integuments of the animals preyed upon), and flow into another delicate membrane situated at the bottom of the tubular bulb, and thence into the stomach.

This organ consists of a branched membrane attached to the body walls; it is furnished with five or seven pairs of pouches, or gastric cæca. In these pouches it is evident that the juices must be assimilated. An Italian writer (De Filippi) says he has noticed special channels of communication between these cæca and the blood-vessels through which the imbibed blood of the victims passes almost directly to the vascular system (?). The general form of the stomach of a snail-leech may be seen in Plate 2, Fig. 1; the dark-coloured contents of which (as seen in Plate 1, Fig. 1) clearly enough reveal the branching cæca—the last pair of which is much larger than the others, and is always directed downwards towards the posterior extremity.

The intestine, like the stomach, is divided into branching cæca, four being the normal number. The intestine ends in a perforation situated on the dorsal surface, at the point of juncture between the posterior sucker and the body.

The circulation in these animals, though clearly seen, especially in young specimens, is difficult to ascertain precisely. It may be enough to remark that the heart is represented by a dorsal vessel extending throughout the entire length of the leech; there is also a corresponding ventral one. The circulating fluid, which is colourless, is propelled by the contraction of the dorsal heart into a number of radiating vessels, which carry it to a couple of lateral canals, one on each side of the animal.

In the red-blooded leeches it is the lateral vessels which contract, in the Glossiphons the dorsal one acts the part of a heart. The blood is no doubt oxygenated by coming in contact with the air contained in the water, principally in the attenuated margins of the body, which are beset with innumerable small blood-vessels. A snail-leech may often be seen to create currents of a fresh supply of water by attaching its suckers to the glass vessel in which it is confined, and by undulating the intervening portion of the body in a vertical direction.

The nervous system is simple, and the entire cord may with care be dissected out. It consists of a double chain of nervous matter with ganglionic knots occurring at irregular intervals (See Plate 2, Fig. 7).

The ovary (Plate 2, Fig. 6) consists of a double sac-like lobe,* situated in the anterior portion of the body. The enclosed vitelli are attached to a long twisted cord, *funiculus* (Fig. 5), but fall from it before exclusion. The mode in which the eggs are deposited, and their development, is full of interest, and readily observed at the proper season of the year.

* A single lobe only is represented in the engraving.

At the time when the Glossiphon is ready to deposit her eggs she may be observed to be very uneasy, twisting herself about in a peculiar manner, and contracting her body violently into one position; by and by a thin jelly-like secretion encircles that portion of the body from which the vitelli come out; simultaneously with the formation of this surrounding belt of jelly, the vitelli are excluded in small masses at a time; they are thus contained within this secretion, and the animal, by a particular twist of the body, extricates its head and neck from the gelatinous belt, which, with its contained vitelli, now forms an egg and adheres to the side of the glass. After an irregular lapse of time the same performance will be again gone through, and a second egg, or batch of vitelli, will be deposited, and a third, or fourth, etc., at intervals. If the reader will refer to what I have said (INTELLECTUAL OBSERVER, No. xi., 1862, p. 357) on the subject of the *Nephelis* engaged in laying her eggs, he will be able to compare the one phenomenon with the other. A viscid secretion, which ultimately forms the vitelline membrane, or egg covering,* occurs both in *Nephelis* and *Glossiphonia;* the vitelli are inclosed after the same manner within this secretion, and both animals extricate themselves from the surrounding belt pretty much in the same manner. But the secretion, which in both forms a vitelline membrane,† remains in *Glossiphonia* unchanged; it is a thin gelatinous fluid, adhering by a pedicle to the substance to which it is attached; while in *Nephelis* the secretion undergoes considerable change, instead of retaining the consistency of thin jelly, it gradually alters, at first assuming a firmer character, and at length, after the lapse of a few days, becoming quite leather-like in its nature.

The *Nephelis,* it will be remembered, uses its mouth, and fixes the egg (capsule and vitelli) to some object; but the Glossiphon appears to press its ova to the sides of the glass by the abdomen. After all the eggs are laid, the Glossiphon—those species, that is, which exhibit this habit—settles down to a quiet domestic life, continuing at home, and nursing her embryo fry. The changes in each vitellus may be readily noted each day, the process of segmentation marked, and the gradual development into a young and perfect Glossiphon watched with delight and instruction. The usual time which a snail-leech occupies in her incubating task is about ten days, but it may be longer or shorter; the embryo drop out of the vitelline mem-

* This viscid pellucid membrane represents the *chorion;* the round grains, which are about the size of a large pin's head, are the *vitelli;* both together forming an *ovum.*

† Dr. Johnson is in error when he states that the vitelli of the snail-leeches are not inclosed in a capsule, which, however, from its transparency, is not readily discernible.

brane—which one may often see in the form of a thin particle of jelly adherent to bodies taken out of ponds—and attach themselves to the under surface of the mother. And a very curious sight it is to see the young fellows popping out their heads on all sides, accompanying their "maternity" wherever she goes, remaining thus tied to their mother's apron strings for six or seven weeks in some cases.

I do not know an instance of any other animal so low in the scale of creation that exhibits so great care for its young ones. Amongst Crustacea, some of the *Isopoda* have been observed to exhibit much affection for their young brood, receiving them, after temporary wanderings, back into the cavity fitted for their protection; and the female *Coccus* deposits her eggs, and then dies as she sits upon them. But not all the species of *Glossiphonidæ* are "sitters." Some, instead of depositing their eggs on foreign bodies, retain them, as I have already remarked, within the cavity formed by the folding inwards of the sides of the abdomen. This is the case with *G. bioculata*, and *G. hyalina*. The number of young ones which the snail-leech produces varies; as few as three and as many as thirty may be contained within each vitelline membrane. The clusters, or ova, also vary considerably in number. So far as I have observed, the large gelatinous species *Glossiphonia tessellata* is the most prolific. Some deposit their eggs as early as April, others in June and July. Upon *G. bioculata* the smallest of the family, is almost invariably found a curious cup-shaped plate. It is situated on the front part of the animal, about the twelfth segment. What its use may be I have no idea; it open out at the upper surface, and is quito characteristic of this species (Pl. 2, Fig. 4). It is very common to see a group of infusoria parasitic upon this membranous plate (Fig. 8). Several species have been described as belonging to this family, but there is much uncertainty about some of them. I will now give descriptions of the following, all of which, perhaps, are true British species :—*Glossiphonia complanata*, *G. bioculata*, *G. tessellata*, *G. marginata*, *G. hyalina*, *G. verrucata*, and *G. eachana*. I am well acquainted with all except the two last named.

G. complanata.—Body, when at rest, almond-shaped, narrowing suddenly at the anterior extremity; back with four or five rows of conical transparent papillæ or tubercles—the two largest and most distinct forming a row on either side the medial axis of the body—and having two dark lines down its middle; these two medio-dorsal lines, which are constant in this species, although sometimes indistinct, are either uninterrupted throughout the entire length of the body, or an even succession of spots; rings, about sixty in number; eyes, six

(hence the specific name of *sexoculata* of some authors), of a triangular form, occupying the fourth, fifth, and sixth segments; sometimes the first pair are wanting, or the whole six are confused and irregularly placed; colour, variable; body, firm, and semi-crustaceous, rolling up like an oniscus when handled; posterior sucker large, and sometimes marked with light-coloured rays; length, from half an inch to nearly an inch (not extended); stomachal cæca, six pairs, the first five being nearly at right angles to the longitudinal axis of the body, the sixth larger, and directed downwards, but not reaching to the posterior sucker; proboscis dilated towards the base, then again narrowing.

VARIETIES.

A. Body greenish, densely sprinkled with minute dots of a dark colour; back marked with large golden spots, arranged in longitudinal lines, which disappear towards the anterior extremity; each spot is formed of a number of small granular spots; the body, as seen under the microscope, is marked with faint reddish patches.

B. Body brown, with very delicate close striæ, both longitudinal and transverse.

C. Body more elongated anteriorly than in the other forms, and softer; the animal less readily assumes a rolled-up form when handled. Colour a light olive brown, the two medio-dorsal lines being less distinct than in the other form of the species. Eyes four, five, or six, nearly always confused. Oval sucker, when extended obtusely, triangular; margins of body more sharply crenated than in the other forms. This variety seems to partake both of the characters of *G. complanata* and *G. bioculata;* it is more slug-like than the normal form of the species. The normal form of *G. complanata* is abundant everywhere, hiding under stones and leaves, and within the stems of aquatic plants. It is prettily marked on the dorsal surface. It deposits its ova, which are sometimes of a delicate pink, on submerged bodies in the months of April and May.

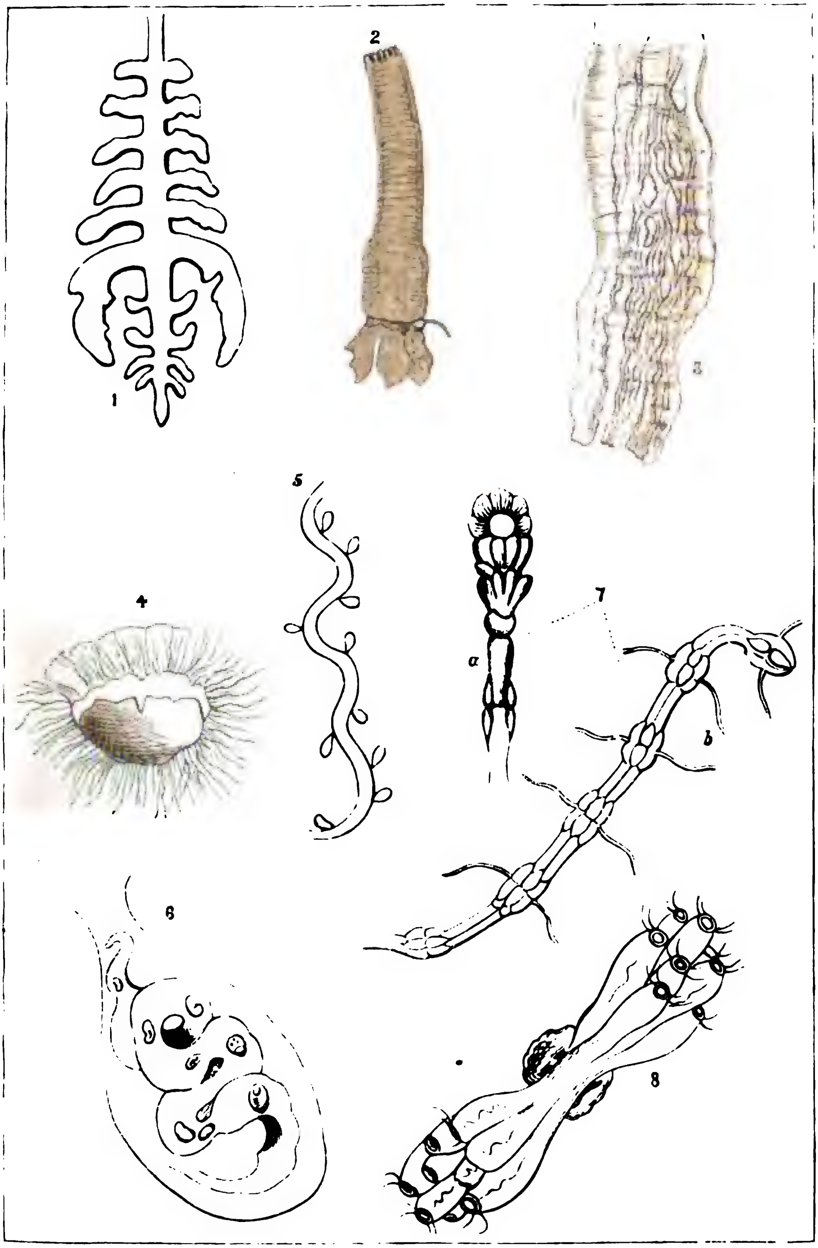
G. bioculata. Body more attenuated anteriorly than the last species, and considerably smaller; colour light brown, or greenish grey; soft; rings distinct, about sixty-four in number, deeply and sharply serrated at margins; eyes two in number, black, situated on about the third ring. Back thickly dotted with minute semiconfluent dark spots, more sparingly towards the margins; a regular row of these spots on each side the axial line of the body, leaving a clear space between the rows. Proboscis distinctly notched at the apex, often protruded to the extent of nearly half its length when the animal is taken out of

the water. A brown, semicircular, coriaceous plate is seen about the twelfth ring, its convex side pointing towards the posterior extremity, opening through the integument of body externally; this plate is sometimes rudimentary. Ova attached to the abdominal surface, the centre of which forms a deep cavity by the folding together of the margins; this is best seen when the animal extends itself in locomotion. Stomachal cæca six pairs, anterior pair divided upwards. This leech often keeps its posterior part doubled up in a heap, and draws it along in this position. This is the smallest of the *Glossiphonidæ*, and is extremely common. It produces its eggs in April, May, and June; the young attaching themselves by their posterior suckers to the abdomen. Length about five lines.

G. tessellata.—The largest and most leech-like of the family. Body, when at rest, oblong, anterior extremity being more rounded than in other species; colour, dull olive green, with about five rows of light yellow spots arranged longitudinally; the spots on the margins are much the largest. Body nearly an inch in length; gelatinous; posterior sucker large; oral sucker sub-triangular, forming, when the animal extends itself, a hollow cup-shaped cavity. Eyes, four pair; the first pair slightly converging. Deposits its ova (June and July) on submerged bodies, and sits upon them; the pellucid vitelline membranes, which are large, may often be found adhering by their pellicles to leaves, stones, etc., after the embryos have left them. The young of this species is very beautiful, being in its earliest stage of a pinkish hue; but this delicate appearance changes to a dull olive, marked with longitudinal lines of white spots. Müller has very correctly observed that this species is so variable, according to age, that the individuals can only be recognized as belonging to the same species by continual observation. It is the most active of the family, and moves about with great celerity. It is generally considered rare; but although certainly far from common, I have little doubt that careful searches after this species would be rewarded with success. It is not uncommon in the Shropshire Union Canal, from whence I have obtained several specimens. I have also found it in weedy pools. It is the most prolific of all the family; as many as 200 young ones may be counted attached to the mother.

G. marginata.—This is a rare but very pretty little Glossiphon; it was added by myself to the English fauna in 1860. I give the description of this species as recorded in the *Annals and Magazine of Natural History*, No. 28, April, 1860, p. 249.

"Body, when at rest, nearly elliptical, but narrowing towards the anterior extremity, capable of great elongation



SNAIL LEECHES.

Glossiphonidæ.

1, Digestive apparatus of a Glossiphon.
2 Tubular proboscis, mag. 20 diameters.
3, Portion of ditto, highly magnified.
4, Cup-shaped plate of G. bioculata.
5-6, Ovary.
7, Nervous system. *a*, Cephalic ganglia.
b, Portion from body.
8, Parasites on cervical plate of G. bioculata.

when it assumes a linear form. Back, when arched, showing the rings distinctly, marked longitudinally with fine regular rows of light yellow dots, equidistant, and thinly sprinkled with smaller dots of the same colour, the centre row alone extending nearly the whole length of the animal. Margins light coloured and transparent, having at intervals two narrow dull-coloured parallel lines, which are at right angles to the axis of the body. Ground-colour of body, claret. Oral sucker constricted at the base, sub-triangular or lozenge-shaped, forming a well-defined head, its extremity being almost transparent. Head with a light claret-coloured patch on either side, giving it, if examined without the aid of a lens, a truncate appearance. Eyes, four, arranged in two longitudinal series, converging anteriorly; the posterior pair much the largest. Posterior sucker very large, round, with about twelve distinct radii. Stomachal cæca seven pairs, with three smaller ones in front; the former bifurcate, and nearly at right angles to the axis of the body; the seventh pair immediately bending downwards and extending to the base of the posterior sucker. Colour of the cæca, a deep green. Length, about six lines."

This species bears in form some resemblance to *G. tessellata*, but it is smaller and not gelatinous. It deposits its ova in June and July, on submerged bodies, and sits upon them. The ova are generally yellow, and the whole abdominal surface of this species at the breeding season is of the same colour. The young attach themselves to the mother, and are carried about by her, as in the rest of the family. *G. marginata* is rare; on one or two occasions I have found it in the Shropshire Union Canal. It is very interesting to note the marks that appear to connect different species of the leech family one with another. I have already observed that *G. tessellata* approaches in some particulars to the character of a true *Hirudo*, or red-blooded leech; in *G. marginata* we meet with some curious resemblances to an annelid of the same family, but of another genus, namely, *Piscicola*. Like *Piscicola*, *G. marginata* is often seen extended in repose, being attached by its posterior sucker, and holding out its body at right angles with the point of attachment. *Piscicola* is often found parasitic upon fish. I have found hundreds of specimens on the dead body of a pike; and it is well known to all fishermen that live fish, such as trout, carp, etc., are often troubled by these worms. Partially parasitic also in its nature is *G. marginata*; if placed in the same vessel with a fish, this Glossiphon will immediately attach itself thereto, and remain there for days together. I have little doubt that it feeds upon the mucus secretion and blood of the fish. I have never seen any of the Glossiphons swimming, but I should not be surprised to find *G. marginata*

an exception to the rule, and to resemble *Piscicola* in this particular as in others.* One point, however, in which the last named worm differs from every species of Glossiphon, consists in its mode of reproduction. The *Piscicola,* after depositing her oval cocoons, leaves them, and the young never attach themselves to the parent.

G. Hyalina.—The most transparent of the family, and widely distributed. Body when at rest oval and much dilated; colour of a transparent amber; back sprinkled with numerous granular orange spots; eyes, three pair, arranged as in *G. complanata.* Anterior extremity pointed; posterior abruptly obtuse; gastric cæca six pairs, anterior smallest, and divided upwards, the rest gradually increasing to the last pair, which immediately bends itself towards the posterior extremity. It carries its ova (June and July) within the abdominal pouch, like *G. bioculata.* This species is very inactive, and rolls itself up when handled. After feeding the stomachal cæca become of a bright vermilion, which, seen through the transparent body of the leech, gives it a beautiful appearance. Müller did not exaggerate when he applied to this Glossiphon the title of "*Vermiculus splendidissimus.*"† The specific name of *Hyalina* will enable the student to identify this Glossiphon at a glance.

G. verrucata.—I know nothing of this species. It is said to differ from *G. complanata* in having seven pair of gastric cæca, instead of six, and in having a body softer than that species.

G. eachana.—Found only in L. Neagh, Belfast, and described by Mr. W. Thompson in the *An. and Mag. of Nat. Hist.*, vol. xviii. (1846). His description is as follows:—"Body oval, anterior portion not dilated into a distinctly formed head, back smooth, margin slightly crenulate, eyes eight; stomachal lobes subpinnate, prevailing hue hyaline. The size commonly extends to nine lines." Mr. W. Thompson says of this species, "The glassy transparency rendered the vessels of the digestive system, which were of a fine dark red colour, very conspicuous, and owing to the jagged outline of the series of lateral lobes, etc., the creature was so extremely beautiful that it might be compared to an arborescent agate." Mr. Thompson's figure somewhat resembles *G. tessellata,* but it appears to be a distinct species.

Several other kinds of *Glossiphonidæ* have been named as claiming distinct specific recognition; but the descriptions are in some cases very vague, and in others they clearly point to

* *Piscicola* is often said to be incapable of swimming; this is a mistake, it swims readily. M. Moquin Tandon says, "Ces Hirudinées ne nagent point." (*Monograph*, p. 293.)

† *Verm. Terrest et Fluviat*, ii. p. 50.

some of those I have described above, either in the young or mature state.

In conclusion, I may recommend the study of this interesting family to the readers of the INTELLECTUAL OBSERVER, as being one which will apmly repay them for their trouble, and which may result in giving us further information as to the number of species which may fairly be supposed to represent this family in the British Isles.*

THE EXHIBITION OF MINIATURES AT SOUTH KENSINGTON.

BY W. M. ROSSETTI.

THE art of miniature-painting is one of the processes of water-colour art, differing from the ordinary processes in proportion to the small scale of its productions. The word "miniature," which has come to mean "diminutive," or "small," appears, indeed, to have had originally no such signification, but to spring from the Latin *minium*, or white-lead, the pigment mostly used in the early book-paintings and initial-designs called likewise "miniatures," but now more commonly "illuminations." But, however this may be, positively or comparatively small size is an essential of miniature-painting, as we now apply the term; and some modification in artistic handling is the needful consequence. The colours, instead of being washed in, or laid one over the surface of another, have to be dotted or streaked on with the point of the brush, or, in the studio phrase, "stippled," or "hatched." Some miniatures are executed entirely on this plan; in others, it is confined chiefly to the flesh-painting. As in most other directions, however, modern intolerance of the restrictions proper to particular forms of art has transgressed the limits of size natural to miniatures; and, some quarter of a century ago, a fashion, almost unexampled till then, arose of painting fair-sized figures, or largeish half-figures, under the name of "miniatures." Now this fashion has almost gone out again, and for a too conclusive reason—miniature-painting has itself almost gone out, hustled off the field by the ease, the semi-infallibility, and the cheapness, of photography. It tends fast to becoming a lost art, and will be absolutely lost in a few

* Some of the figures which illustrate this article are copied from the late Moquin Tandon's *Monographie de la Famille des Hirudinées*. Paris, 1846. They will facilitate identification, being good representations; the other figures were originally drawn from specimens.

years—in England, at least—unless the tide of taste should somewhat turn. That this *should* turn is most highly desirable; and there can be little doubt that the art, if culpably allowed to die out now, will have to be revived at some future time, under the disadvantages native to all such revivals. No beautiful art, no sphere of development for human skill, ought ever to be permitted to come to an end. Miniature-painting *is* a beautiful art, and people will begin to rediscover that when they get tired of being represented, on the small scale fit for gifts and *souvenirs*, only by mechanically produced and indifferently coloured photographs. We wish all possible honour and development to photography, but not a monopoly fatal to the miniature or any other fine art.

We have said that miniature-painting is a water-colour process; and so it almost universally is, upon the materials most peculiarly appropriate to it, which are vellum, card, and, in more recent times, prepared ivory. This last, which now counts as the miniature material *par excellence*, was not introduced into use until about 1685. Even on this material, however, oil-colour has been occasionally used, not with good effect (as in the heavy, lightless series by Andrew Robertson, a once highly admired practitioner, in the South Kensington Exhibition); and, in a wide acceptation of the term, various other sorts of pictures or designs are accepted as miniatures. Mr. Samuel Redgrave, the compiler of the catalogue for this exhibition, says, "Miniatures may be painted or drawn on any material, and with any material used by the artist, and in every style of art. It was deemed best, in the interests of the exhibition, to accept all such works as were drawn to a small scale, and were, in respect to manner, of a miniature character, except paintings on porcelain." Thus the exhibition includes the singularly-perfect enamels of Petitot, and those of his successors, which is obviously reasonable. We cannot quite agree, however, in the admission of ordinary oil-portraits of moderate size—say from a foot to a foot and a half—painted upon canvas or panel, and of similar-sized water-colours or pencil-drawings upon paper. To us it appears plain that these are not, in any fair sense of the term, miniatures; and the admission of a few of them seems to suggest that, if any at all, there ought to be many more in proportion. They are here also necessarily hung at a height which, slight as it is, prevents them from being examined with entire satisfaction, considering their limited size.

We pause a moment to describe, in the words of Mr. Redgrave, the process of the enamel art above referred to, which is, of course, a wholly different thing from miniature-painting, and more analogous to porcelain painting. "The

art of enamelling is of great antiquity and uncertain origin. . . . About the beginning of the fifteenth century, by an improved process, painted enamels became applicable to miniature-portraits; an art which was certainly derived from France, but was not brought to much perfection till towards the middle of the seventeenth century. In 1632, a goldsmith, Jean Toutin, who was skilled in the use of transparent enamels, produced a variety of colours which, when used upon a thin ground of white enamel, vitrified in the furnace without any change of tint. These colours were applied in the same manner as water-colours used on vellum or ivory; they were the materials of the first miniaturists, and, a few years later, they enabled the great Jean Petitot to carry the art to its highest excellence. They consisted of metallic oxides, with fluxes of vitrifiable substances, chiefly silica and borax, both fusible at a heat capable of being resisted by the metal ground, whether gold or copper, on which they are to be used. It is also essential that these materials should be of a character to adhere firmly to the ground, should possess the transparency or opacity required to give finish to the artist's work, and maintain, after fusion, a smooth, clear, vitreous surface. The colour produced results either simply from the colouring material used, or from the chemical combination of that material with the flux."

Miniature proper (to which we now revert)—the painting in water-colour with the point of the brush upon card, vellum, or ivory—has been a specially British art. The names of some foreign artists, as for instance Holbein, stand indeed in the first rank of the art; but, perhaps, the most entirely typical specimens of it, executed by artists who were nothing or hardly anything save miniature-painters, are those left to us by our countrymen, Nicholas Hilliard, Isaac and Peter Oliver, and Samuel Cooper, in the sixteenth and seventeenth centuries; by Cosway at the end of the eighteenth and the beginning of the nineteenth; by his finest successor Ross; and in the latest development of the art by Thorburn and Wells, living artists who have survived the art whereby they acquired their fame, or at least have had to "give it over" in its now moribund condition, and occupy their talents otherwise. Mr. Redgrave speaks of "the inimitable Samuel Cooper," seeming to imply that that master of the Cavalier and Roundhead period was the prince of all miniature-painters. Recognizing his singular excellence, we yet think that the still earlier painters, Hilliard and Isaac Oliver, represent the very finest condition of the art. The miniature method of execution, small dainty touches upon the smoothest of surfaces, indicates the artistic qualities most suitable to such works. These are delicate precision, clearness, and harmonious nicety. The smaller the works are the better,

else there is no reason for such smallness of handling. Similarly, they deal best merely with a head and shoulders, for there is not adequate room for more; they should eschew dark shadow, for a small work much shadowed is in total effect a blot; they should aim at the utmost simplicity of pose and motive consistent with elegance, and stopping short of formality, for more of vividness and variety requires space for its proper development; they should be bright and decorative, for they belong to the *bijou* order of art; and, being thus, and comparatively devoid of shadow, they are none the worse, but rather the better, for a certain general look of flatness. Card or vellum, as of old, is probably a preferable substance to ivory for miniature-painting, as the excessive smoothness of the latter favours overloading of colour, or else produces want of solidity. The reader who knows the qualities whereby the old sixteenth-century miniatures are specially distinguished from their successors, will perceive that those miniatures are the most thorough embodiment of all the æsthetic and executive virtues we have here attempted briefly to summarize, and that the productions of after times, up to our own, have more and more deviated from this ideal, increasing in size and decreasing in whatever separates the miniature from other forms of art. In fact, the comparison between Hilliard and Cooper rests on much the same basis as that between Holbein and Vandyck, as portrait painters on a larger scale; with this difference, that, while it may be questioned which of these admirable oil-painters developed the style better suited for large work, there can be little doubt that the Holbein-like style is the more applicable to the small scale and special execution of miniatures. Cooper may, however, be regarded as having extended though not improved upon the art, and as dominating all subsequent developments of it up to the time when Cosway, a painter of great ability and elegance, struck the keynote which has prevailed from that date to this. He is the Reynolds, and to some extent the Lawrence, of miniature art, doing his portraiture "with an air:" he produced and represents the transition from the work of the eighteenth to that of the nineteenth century. The latter is known to all of us, and has already been sufficiently referred to.

The Exhibition of Portrait-Miniatures which opened at the South Kensington Museum on the 1st of June, got up by the Educational Committee of Privy Council, with the assistance of an influential advising body, is probably the richest in number and quality ever organized in this or even in any country. It contains 3081 works, lent by a large number of owners, and representing the art chiefly as practised in the United Kingdom, but not by any means exclusively so. Of

course the exhibition has a double and emulous interest; the interest of the works as artistic productions, and the interest, historical or other, of the persons pourtrayed. Scores and scores of the most famous men and women of the past three centuries and a half are here brought visibly and vividly before us; in many cases we can trace their progress from childhood or adolescence to old age, and see the stamps set upon them by time and chance, by passion and self-interest, by self-control and abnegation, by intellect and folly. We shall now proceed, with but little attempt at classification and still less at exhaustiveness, to pick out a few bricks from this beautiful Babylon. Our selection will be guided by the double interest we have just adverted to—that of the painting itself on the one hand, and of the sitter on the other; the interest, however, is so frequently fused, the best sitters eliciting the highest skill of the finest artists, that we shall not make any formal division between the two classes of examples. We may add that the compiler of the catalogue explains that the names of both artist and sitter are, with few exceptions, given as stated by the owners of the miniatures, and that the catalogue cannot therefore be appealed to as authority on this point—a circumstance we may regret, but can hardly complain of under the particular conditions which affected the present collection. We must also apologize to the owners for omitting, with a view to space, their names in our enumeration of the works: for this detail of great practical importance we must refer the student to the catalogue—the choice for ourselves being between the omission of owners' names, and that of some portraits which fairly claim to be specified.

BRITISH PORTRAITS BEFORE AND DURING THE TUDOR PERIOD.

Edward IV. and others. Water-colour, or what is usually termed an illumination, on paper; this must be the oldest work in the exhibition, or rather, as explained in the catalogue, a copy of such a work. It is inscribed as follows: "Earl Rivers presenting his book, and Caxton his printer, to Edward IV., the queen, and prince. From a curious MS. in the Archbishop's Library at Lambeth. The portrait of the prince (afterwards Edward V.) is the only one known of him, and has been engraved by Vertue among the heads of the kings. The person in a cap and robe of state is probably Richard Duke of Gloucester, as he resembles the king, and as Clarence was always too great an enemy of the queen to be distinguished by her brother. The book was printed in 1477, when Clarence was in Ireland."

Henry VII. "Represented holding four heartsease flowers

in his crossed hands; a female hand is approaching his breast, above which is the inscription, *A corde cor traho.*"

Henry VIII., 1526, by Holbein. A three-quarter bust portrait.—By the same (No. 1392). Oil. Fair, but not particularly fine for Holbein.—By the same (No. 2082).—Henry VIII., about thirty, ascribed to the same. Neither the quality of the painting, nor the evidence of dates, favours the assumption that this work is by Holbein. That painter did not come to England till 1526, whereas Henry was thirty years of age in 1521.

Catherine of Arragon, by the same. From Strawberry Hill, and stated by Walpole to have been "given to the Duke of Monmouth by Charles II." Fine.

Anne Boleyn, ascribed to the same. Not rightly so ascribed, we venture to affirm.

Jane Seymour, by the same. Crayons tinted.—By the same, inscribed "ano 25."

Anne of Cleves, by the same. Oil. This is substantially the same as the well-known portrait of Henry VIII.'s "Flanders Mare;" it seems to have been re-painted to some extent. The face is heavy and not attractive.

Thomas Howard, third Duke of Norfolk, by the same. Oil. A mild look characterizes this Duke, the father of the poet Sanrey, and remembered in history partly through his good luck in the death of Henry VIII. the day before that which the monarch had appointed for the Duke's execution.

Alicia, wife of Sir Thomas More, by the same. Admirable.

Sir Nicholas Poyntz, by the same. Good, but rather too minute, and perhaps a questionable Holbein. That painter included Poyntz in the series of portraits at Windsor Castle.

A Lady, by the same. "Anno ætatis suæ, 23: her coat of arms is affixed to the case." Somebody ought to trace out this coat of arms, and tell us who the lady was. It is a quiet, simple, composed face, not beautiful, and looking some few years older than the recorded age; and, as a work of art, amazingly perfect and true, perhaps the very finest thing in the exhibition. The owner, Mr. J. Heywood Hawkins, may be congratulated upon possessing, of its class, one of the finest objects in the world.

The Earl of Kildare, by the same. Oil. Excellent.

The Countess of Kildare, by the same. Oil. Also very fine.

Edward VI., 1547, ascribed to the same. This is in a fine miniature style, with clean-cut touch, the colour very flat and sunken. One may safely say, however, that it is not by Holbein, who died in 1543, according to recent evidence which appears indisputable, and has not, indeed, we believe, been disputed.

The Protector Somerset, by Hilliard, 1560. A posthumous portrait, or perhaps a copy of a portrait from life, the decapitation of the Protector having taken place in 1552.

Queen Mary I., by Sir Antonio More. Oil.—By Luis de Vargas, 1555. Oil. A very fine head-and-shoulders portrait, of fair size.—Another, author anonymous (No. 1282). Appears to our eyes of more than doubtful authenticity. The costume belongs rather to some twenty or thirty years after Mary's death, and the type of face suggests a princess of the Austro-Spanish family.—By Holbein. At an early age, perhaps sixteen, when, according to the evidence of this portrait, the princess had pale golden hair.

Edward Courtenay, Earl of Devon, the suitor regarded with some favour by "Bloody Mary." "He is represented in a white shirt, with open lace collar, holding a chain or bracelet, and locket, the latter being suspended round his neck; behind him, in the background, rise flames." This last is a very curious detail in a fine miniature.

The Regent Murray, "An. 1566, Æta. 33," by Antonio More. Oil. Very fine.

Queen Elizabeth, by Hilliard. A somewhat broader face than in most portraits.—Another, anonymous. Seems about the age of nineteen, with a boyish look.—By I. Oliver. A very pretty miniature, with an almost Chinese absence of shadow.—By Hilliard, in a very richly jewelled dress and lace ruff. This is one of those old miniatures in which the almost entire absence of colour from the flesh is a salient peculiarity, and a defect. We scarcely know how far this may be the intentional manner of the artist, or how far it may be the effect of time and exposure. As Mr. Redgrave says in his catalogue, "It is truly painful to see how many fine miniatures have been exposed to the sun, till all their colour has been absolutely burnt out, while others have equally suffered from damp, or from the absence of the most ordinary protection required for works of such minute delicacy." Certain it is, however, that this facial pallor is often found associated with sufficiently full tints in the costume, as in the miniature of which we are now speaking.—By Zucchero, "A Young Lady, supposed to be Queen Elizabeth as Princess." This gives a front and a back view of the head, and is, in all respects, most charming. We wish it were possible to "suppose" the original to have been Elizabeth, but the evidence of dates makes such a suggestion quite absurd. When Elizabeth was about sixteen, the age to which these portraits may be referred, in 1549, Federigo Zucchero was a boy of six; when Zucchero came to England in 1574, Elizabeth was a woman of forty-one.—By Hilliard, at about sixty years of age.—A pro-

file, painter anonymous. "It is stated on the back of the miniature, that this was the only portrait of her taken in profile." Age somewhere towards thirty-six. This is a grand head, more massive in type than in most of the portraits.—By the same, about the same age, or rather younger. A fine portrait.—Ascribed to the same, a portrait of fair size, towards the age of forty-five, in which Elizabeth is represented crowned and decked with jewels.—By the same, "mounted in an oblong snuff-box; a small and elaborate miniature, representing the queen in a black dress *semée* with pearls, rubies, etc., and wearing the usual high lace ruff, from which pearls are pendent." A very small miniature, and a perfect specimen of about the best possible style of the art.—By the same, "Ano Dni. 1564, Ætatis suæ 25." The hair here is of a bright copperish tint, more strong than in most portraits.

Mary, Queen of Scots. "1565, Ætatis suæ 24." This is a vulgarish-looking portrait, and, we should say, not recognizable as intended for the fascinating queen.—After Cornelius Jansen. Enamel. Said to have been taken in Paris before the death of her first husband Francis II.—The same, inscribed "la Royne Dauphine." Panel. An excellent work, showing Mary in her girlish loveliness. Perhaps, however, one would scarcely recognize it as being meant for her.—The same, half-length, in a black hat over a lace cap. Graceful in her stiff dress.—After I. Oliver's original in the Royal Collection. Has more of the look of a Dutch Frow than we are accustomed to ascribe to the Queen, yet not unpleasing.—School of Clouet. Oil. "This portrait, purchased at Paris in 1821, represents her just after her marriage (1558) with the Dauphin."—The same, "an elaborately finished miniature, representing the Queen with light auburn hair, wearing a crown, with jewelled collar and badge, in a rich dress with full sleeves slashed down the arm. She is playing on a lute, and is seated in a high-backed chair, each arm of which is surmounted by a globe and crown—one being that of the Dauphine of France; the other may be intended for that of England." This is a very charming portrait, combining a genuinely royal aspect with a certain poetic or romantic quality, as of one of the ladies in the Decameron.—By Hilliard, 1579. A good record of the Queen in her thirty-eighth year, showing more solidity of facial form than in most portraits.—The same, painter anonymous. "Face to the left, wearing a close ruff, and black veil falling behind." A neat miniature, much stippled. As it stands, it hardly appears to be a contemporaneous work, but may probably be such a work re-touched.—An oil-portrait, painter anonymous. A very pleasing likeness, both girlish and queenly, at about the age of seventeen.—Mary and her son

James, with Edinburgh in the background, ascribed to Hilliard. —Ascribed to the same, Mary, with a somewhat gipsy-like expression. "Given by Mary to one of her maids of honour on the [which?] occasion of her marriage; from whom it descended to her grandson, the second and last Earl of Middleton, who died 1695."—The same, painter anonymous. "Small full-length portrait, holding a crucifix in her right hand, and a book in her left; beside her, on a table, is a crown and sceptre, and in the field to the right are painted the royal arms of England. Inscribed 'Maria Stuart, anno 30.'" A notable and pretty little portrait. We may add that this series of miniatures only confirms, what is well known to investigators, that the divergences between the various so-called portraits of Mary Stuart are extremely serious.

Robert Dudley, Earl of Leicester. Younger than in most of the portraits, say about thirty-four years of age, with hair already thin.

Robert Devereux, Earl of Essex, by I. Oliver. Unfinished. —The same, 1588. Oil on copper.

William Cecil, Lord Burleigh. A small full-length.—Another, age about forty, with a knowing, penetrating glance.

Thomas Howard, fourth Duke of Norfolk, by Sir A. More. Oil. Inscribed "Ætatis 25, 1562." This is the Duke of Norfolk, son of the beheaded Surrey, and himself beheaded under Elizabeth. The portrait is a fine one, like a Holbein.

Sir Francis Drake, by Hoskins.—By Hilliard, inscribed "Ætatis suæ 42, Ano Dni. 1581." If 1545, the date of birth ordinarily given, is correct, Drake can only have been thirty-five or thirty-six in 1581. This portrait bears some resemblance to one which is catalogued as Sir Philip Sidney.

Sir Walter Raleigh, "Ætatis suæ 65, A.D. 1618."—The same, by I. Oliver. Looks hardly more than some twenty-one years of age, the face less long than in some other portraits.

Henry Wriothesley, Earl of Southampton, "the friend and patron of Shakespeare," 1616, by the same. This portrait shows a well-made face, in early middle age, with a slightly Jewish expression. There is nothing in it conspicuous enough to favour the theory that the friend whose personal beauty is so enthusiastically praised in Shakespeare's sonnets can have been Wriothesley.—By P. Oliver. A very aristocratic head; somewhat too much so perhaps, as if the blood had run pure so long that it had begun to thin. One may notice a certain resemblance to Charles I.

Sir Philip Sidney, ascribed to I. Oliver, inscribed "Anno Domini 1586, Ætatis suæ 19." Sidney was properly thirty-two years of age in 1586, the date of his death. This portrait presents light curly hair and a wry mouth; perhaps it is not

to be implicitly trusted.—The same, painter anonymous, inscribed "Ano Dni. 1582, Ætatis suæ 28." A very unprepossessing portrait, and unlike the accepted head of Sidney. The hair here is black, or at any rate very dark, and the cast of features the reverse of aquiline.

A Lady, in the costume of the early part of Queen Elizabeth's reign, by Zucchero. Oil. Admirable.

Lord Hunsdon, by Hilliard, 1605, Cousin and Master of the Horse to Queen Elizabeth. An admirable example of the style of this golden period of the miniature art.

(*To be continued.*)

THE WEATHER.

BY A. S. HERSCHEL, B.A.

"Changeable as the weather," "fickle as the wind," are proverbs whose truth is confirmed in so many instances that no meteorologist will venture to deny them. To interpret the frowns of the weather, and to predict its storms, is at best his thankless task; but to trace its fundamental laws to all their irrevocable conclusions evidently transcends the powers of human thought. The laws themselves are not many, nor difficult to understand, but the immense diversity of circumstances under which they are applied, makes it impossible to follow them out to their actual results. An outline only of the general laws can be presented, and every reader of the Intellectual Observer will doubtless be able to add some jot or tittle to the store.

Torricelli, a friend and intimate of Galileo, who flourished about the middle of the seventeenth century, discovered that the earth, and its envelope the air, are surrounded by a vacuum. This, which is called the "Torricellian vacuum," is imitated whenever water is attempted to be raised by suction to a height exceeding thirty-three feet. The celebrated experiment of Torricelli was to show that the same vacuum is produced when mercury is attempted to be raised by suction in a tube to a greater height than thirty inches. In fact, in either of the two supposed cases, the air and the water, or the air and the mercury, balance each other by their unassisted weight, and the height of the atmosphere is made known by the height of the column of the fluid.

The height of a column of mercury at freezing temperature, which balances the average weight of the atmosphere at the sea-level at Greenwich, is 29·953 inches. Thirty inches of

mercury (in round numbers), at freezing temperature, approach so nearly to the average pressure, that this pressure is called the standard pressure of the air. In rising to a greater height above the sea, or if air becomes lighter at any place, or a portion of it flows off from the top of the atmosphere, the pressure becomes less, and the column of mercury becomes shorter. From this circumstance an instrument constructed on these principles, and known after its inventor as the "Torricellian tube," is called a barometer (βᾰρυς, *heavy*; μέτρον, *a measure*), because it measures the weight of the atmosphere (whether in rest or motion) over any place where it is used.

Air at standard pressure, and at the temperature of freezing water, is 10,486 times lighter than the fluid mercury by which its weight is measured. The height of the atmosphere, it might be supposed, is therefore just so many times greater than thirty inches; or, in other words, five miles all but sixty-two yards. This height of a "homogeneous atmosphere," as it is called, is, however, only imaginary, because it is well known that air is an elastic fluid, which presses on everything (at constant temperatures) in proportion to its density. The densest of the atmosphere is, therefore, below, and the rarest part above. So far as barometric observations have extended, the standard pressure of the atmosphere remains the same, and air does not appear to leave the earth. A definite limit to the atmosphere, therefore, probably exists, but at what distance from the earth, whether at 100 or 150 miles, or upwards, is not known, although certain circumstances lead us to suspect about that height.

The law of rarefaction in that part of the atmosphere which need be considered in meteorology is, however, this, that while the height increases in arithmetical, the pressure and the density diminish in geometrical progression. Consider, for example, the decimal fraction 0·999, etc., continued *ad infinitum*, to represent by unity the whole weight of the atmosphere in any column from the level of the sea. The amount of it contained, by weight, in the first ten, twenty, thirty miles, etc., above the sea, is represented by the first one, two, three, etc., figures of this decimal. This is, in fact, not merely an illustration, but a near approximation to the truth. Thus at a height of ten miles above the sea nine-tenths of the atmosphere are left below, and one-tenth part of it only remains above. Ten miles compared to the diameter of the globe is no thicker than the roughness of an egg, but even in this small depth the lower half contains twice as much atmosphere as the half above. The sensible atmospheric covering of the globe, therefore, transcends very little the tops of the highest

mountains, yet in this thin covering all the wonderful changes of the weather are produced.

In the early part of the present century Sir Humphrey Davy pointed out among the first, that dry air, at whatever time, or in whatever part of the atmosphere it is collected, consists of nearly twenty-one parts of oxygen and seventy-nine parts of nitrogen, by volume, in an invariable proportion. This fact was also confirmed by Gay Lussac in his balloon ascents, and is a point of special importance in physics, where the specific gravities of gases are referred to that of dry air as a standard.

Besides oxygen and nitrogen, the atmosphere contains a very variable amount of aqueous vapour. One and a-half per cent. of this gas, by volume, may be taken as an average proportion between the extreme of dampness and dryness of the air. Carbonic acid gas is another variable constituent of the atmosphere, and its volume, on an average, is little more than a twentieth part of that of aqueous vapour. According to the theory of Dalton, these gases are all mixed together, without any preference among themselves.

With the exception of hydrogen and ammonia among the gases, and the vapours of a few volatile ethers, aqueous vapour is the lightest known gas. The following table of specific gravities will make this clear.

Table I.—Specific gravities of certain gases in the atmosphere :—

Hydrogen	0·069
Ammonia	0·597
Aqueous vapour . . .	0·624
Nitrogen	0·971
Dry air	1·000
Oxygen	1·106
Carbonic acid gas. . . .	1·529

A mixture of air and aqueous vapour is, therefore, comparatively buoyant; but a mixture of carbonic acid and air, or "choke-damp," as it is called, is heavier than common air, and therefore remains *in situ* at the bottom of shafts and wells, whilst moist air rises to the summit of the atmosphere.

By an admirable course of experiments at the Royal Institution, Dr. Faraday showed that a number of gases—chlorine, for example, among the elements, and carbonic acid gas among the compound gases—are converted by high pressure into liquids. The liquids again resolve themselves into gases when the pressure is relieved. Aqueous vapour comports itself in every respect like a gas, of which the liquid form is water.

An instrument well adapted to illustrate this peculiar property of aqueous vapour is the cryophorus. This is an instrument composed of two glass globes connected together by a bent glass tube. The whole is completely exhausted of air, and the globes are partly filled with water. In this condition the cryophorus resembles a kind of "water-hammer," for when the water is emptied from one globe into the other, it rattles with a noise like falling ice. To use the instrument, the emptied globe is placed in a freezing mixture of pounded ice and salt. The other globe, containing water only, is exposed freely to the air. A brisk evaporation commences immediately from the surface of the water, and the vapour passing over to the bulb imbedded in the freezing mixture is condensed. While water is converted into vapour, a large quantity of sensible heat is rendered latent. If this is not supplied from without, the effect of evaporation is to lower the temperature of the bulb, and at last to freeze the water it contains. On this account the instrument is called a cryophorus (*κρύος, cold; θέρω, I carry*); because cold, in effect, is carried from the freezing mixture to the other bulb. The principles illustrated by this experiment of the cryophorus are those of the condensing steam-engine, and of the exhausted evaporating pans employed by refiners for crystallizing sugar. The boilers in these machines are supplied with external heat, and the condensers are kept cool by running water.

At high temperatures great pressure is required to reduce a gas to its liquid form, or, in other words, the greater the temperature of a liquid the greater is the pressure of its vapour. Boilers are thus replenished by vapour, of a pressure corresponding to the temperature of the water. The space within the boiler is in this case said to be *saturated* with vapour. At a high pressure (and temperature) great mechanical effects can be produced. In the cryophorus, above described, and in performing distillation at low temperatures, the saturating pressure of the vapour is also low.

Maury has actually described the atmosphere as "incomparably the greatest steam-engine with which we are acquainted." The temperature of the air at the equator is 83° Fahrenheit, and the mean temperature at the coldest places near the Poles is little above the zero point of Fahrenheit's scale. A similar depression of temperature is found in ascending 50,000 feet into the air. The atmosphere therefore more nearly resembles an immense cryophorus, or vast distilling apparatus, of which one boiler is placed at the equator and its condenser at the poles, and another boiler is placed at the base and its condenser at the summit of the atmosphere. Were the air at rest, an universal cloud-canopy would envelope the earth by reason of

a continual process of vertical and horizontal distillation, and the beneficial rays of the sun would thus be excluded. But the pressure of the vapour is very small (seldom exceeding an inch of mercury at the equator), and the powerful impulses of the wind are sufficient to convey to every part of the globe the salutary changes of weather which it requires. Thus it happens that dry air and fine weather are everywhere imported from the polar quarter of the globe, and rain and cloud from the opposite direction by the wind.

The atmosphere is accordingly far from being everywhere so saturated with vapour as if it were at rest. To determine the proportion of its moisture to that of complete saturation, or, in other words, the *relative humidity* of the air, at all times and places, is the special object of hygrometry. Different instruments called hygrometers (*ὑγρός, moist; μέτρον, a measure*) have been invented for this purpose, but with only partial success. Daniell's hygrometer (or different forms of this hygrometer), and Mason's hygrometer, or the wet and dry bulb thermometers, yield the most satisfactory results. The first of these instruments fixes at once the "dew-point" of the air, or the temperature at which its moisture begins to be deposited in the form of dew. This is the temperature to which air must be reduced in order to saturate it completely with the vapour it contains. The pressure (or amount) of its vapour is then easily ascertained from a table of saturating pressures, as well as the additional amount necessary to complete the saturation of the air. Mason's hygrometer consists of two ordinary thermometers, the bulb of one of which is kept constantly wet, and shows the "temperature of evaporation." The bulb of the other thermometer is dry, and registers the temperature of the air. From the readings of this instrument a set of hygrometrical tables were constructed by Mr. Glaisher, which afford, under all circumstances, the required conditions of the air. These are—1st, its dew-point; 2nd, the pressure of its vapour; 3rd, its relative humidity (before described); 4th, the weight of water contained in a cubic foot of the air; and 5th, the additional weight of water required to saturate a cubic foot.

It has been remarked by Redfield, one of the first meteorologists in America, that very brisk winds are often limited vertically to very thin sheets or layers of the air. "Few facts," he writes, "in meteorology are more worthy of our attention than the stratiform character and vast horizontal extension of the aërial currents in different parts of the globe." This characteristic property of the atmosphere, by which its extensive ventilating system is rendered complete, undoubtedly forms one of the most striking features in meteorology. In describing the vast circulation of the trade winds, the consideration of

its effect cannot be omitted; but even in the course of ordinary observations the horizontal arrangement of the clouds, and their cross-currents, one above another, afford daily means of verifying the horizontal direction of the wind.

Suppose a current of air to descend from above, with the velocity of an ordinary gale of wind, which is sixty miles an hour, from an extreme height of ten miles above the earth. In ten minutes it would arrive at the surface of the earth. The elastic pressure of its mass would at the same time be increased about tenfold. A very ordinary experiment, and one recently improved by Dr. Tyndall, may be taken to illustrate the change that would thereupon occur in the intruding mass.

When air, confined by means of a piston in a tube, is suddenly compressed to a tenth or a twentieth part of its original volume, the heat developed by the sudden compression, it is well known, is such that tinder, punk, or amadon attached to the end of the piston is instantly ignited. Such an instrument is called a fire syringe. In its new form the tube is made of glass, and a small portion of combustible gas is included with the air. A bright and vivid flash at the moment of compression then gives ocular demonstration of the violence of the heat. Lest the circumstances of the wind should not be considered as adequately represented by the conditions of this experiment, it may be calculated that air submitted to a tenfold pressure must have its temperature elevated to the extent of fully a thousand degrees Fahrenheit. This is therefore what would take place in the descending mass, which would be rendered buoyant by the heat developed, and would return rapidly to the summit of the atmosphere by the force of gravity alone.

In a less extreme case, when wind is only slightly deflected from its horizontal course either upwards or downwards by any interruption, it quickly returns (by the force of gravity) to its accustomed level, on account of the change of temperature that attends its change of elevation.

Main currents of the air are therefore horizontal, and violent currents of the air, in a vertically ascending or vertically descending direction, are, from the nature of the case, impossible.

The mainspring of ventilation in the air is the ascensional force of air and vapour imparted to wide tracts of the atmosphere by the ardent rays of the sun, scattered again in other spaces by radiation from the earth. The focus of the sun's action describes a diurnal circle round the globe, which is in the equator at the time of the equinoxes, and at either tropic at the solstitial seasons of the year. The latter circles receive their name of tropics from the fact that the sun, although it

remains longer over these circles than over any other circle of the globe, returns at these times to seek the other tropic at the other side of the equator. In the frigid zones of the globe, within the Arctic and Antarctic circles, the sun remains for days and months together invisible beneath the horizon. To illustrate the intensity of the opposite causes operating in these different regions of the globe, two kinds of thermometers are employed, called solar and terrestrial radiation thermometers. The former has a blackened bulb, surrounded by an exhausted globe of glass, and it occasionally marks 50° F. above the temperature of the surrounding air. The latter is an ordinary minimum thermometer, and is exposed at night upon the grass. When exposed on wool or feathers it has been observed by Mr. Glaisher at Greenwich to fall as low as 30° F. below the temperature of the air. In both cases the temperature of the air is that of a thermometer in the shade suspended four feet above the ground. This measure in some degree indicates the extent of the causes whose contrast from the equator to the poles produces the prevailing direction of the wind.

The temperature of the air at the equator is 83° Fahrenheit, nearly without vicissitudes throughout the day or year. In higher latitudes the temperature is not only less, but it is subject to two oscillations, one depending upon the seasons and the other upon the alternation of day and night. The following table exhibits the average value of the first oscillation, at Greenwich, from the mean of fifty years (1814—1863), above and below the mean temperature of 49°·03 Fahrenheit.

TABLE II.—Annual curve of mean monthly temperatures at Greenwich, for fifty years (1814—1863) :—

	Deg.		Deg.		Deg.
Jan.	— 12·1 (F.)	May	+ 3·9 (F.)	Sep.	+ 7·6 (F.)
Feb.	— 10·3	June	+ 10·1	Oct.	+ 1·2
Mar.	— 7·3	July	+ 12·8	Nov.	— 5·8
April	— 2·8	Aug.	+ 12·2	Dec.	— 9·2

The table shows that the seasons are not distributed according to the quarters of the year, but there is a range of nearly 25° (F.) between January and July, which are respectively the coldest and the hottest months. *December, January,* and *February* compose the Winter, and *June, July,* and *August* compose the Summer season. Spring and Autumn occupy the intermediate months. A comparison of the temperature of every day for the same number of years shows that, at Greenwich, the 8th of January and the 15th of July (St. Swithin's Day) are respectively the coldest and hottest days on the average of fifty years.

The daily oscillation of temperature, at Greenwich, from the average of five years (bi-hourly observations, 1841—1845), is represented by the following table, above and below the mean temperature for the period.

TABLE III.—Diurnal curve of temperature at Greenwich for five years (1841—1845):—

	Deg.		Deg.
1 h. a.m.	— 3·4 (F.)	1 h. p.m.	+ 5·1 (F.)
3 h. „	— 4·2	3 h. „	+ 5·8
5 h. „	— 4·8	5 h. „	+ 4·4
7 h. „	— 3·9	7 h. „	+ 2·0
9 h. „	— 1·2	9 h. „	— 0·6
11 h. „	+ 2·3	11 h. „	— 2·3

About an hour before sunrise (5 h. a.m.) is the coldest time, and three o'clock in the afternoon is the hottest hour of the day. The average daily range is 10°·6 (F.). These hours and the daily range vary very considerably in the different months. Wherever observations are continued at a particular hour of the day, special tables are therefore required for every month, to deduce the "mean monthly temperature" from the mean temperature observed at any hour. Where, however, self-registering maximum and minimum thermometers are used, a simpler method is to ascertain the average highest day temperature, and the average lowest night temperature for the month. The arithmetical mean between these quantities is always *higher* than the true mean monthly temperature of the air by the amount contained in the following table.

TABLE IV.—Correction to be applied subtractively to the arithmetical mean between the average highest day temperature and the average lowest night temperature for any month, observed with self-registering thermometers, to obtain the true mean monthly temperature:—

	Deg.		Deg.		Deg.
Jan.	— 0·2 (F.)	May	— 1·7 (F.)	Sep.	— 1·3 (F.)
Feb.	— 0·4	June	— 1·8	Oct.	— 1·0
Mar.	— 1·0	July	— 1·9	Nov.	— 0·4
April	— 1·5	Aug.	— 1·7	Dec.	— 0·0

Twelve mean monthly temperatures having been obtained by either mode, the average of all is the mean temperature for the year. This is found to be a very constant quantity, although the annual range of temperature is subject to very considerable variations.

The mean yearly temperature of the air having been determined by observation at different places of the globe, lines of

equal temperature, or "Isotherms," as they are called (*ἴσος, equal; θερμός, hot*), are drawn round the globe, giving equal weight to every place. It is then found that the temperature of the air on the western coasts of Europe is higher, especially as compared with the eastern coasts of Asia and America, than the ordinary temperature for the latitude. The same excess is also observed on western, as compared with eastern coasts in every part of the world, but the annual range of temperature is less. Thus, from Gibraltar to Norway the range varies between 15° and 35° (F.). From Florida to Labrador, on the opposite coast of America, the annual range of temperature varies between 30° and 50° (F.). At Pekin, on the eastern coast of Asia, in the latitude of New York, the range of temperature is 60° (F.), but near Vancouver's Island, in higher latitude, on the western coast of North America, it is not so great by half, or less than 30° (F.).

In this general feature of the weather, the predominating winds play an important part, as will hereafter be explained. Not only do they elevate the temperature, but, bringing with them clouds, the land under their influence neither loses nor acquires its heat so rapidly as in countries less affected by their action.

On the borders of the Great Sahara, at sunrise in December, it is no uncommon occurrence for ice to be found upon the shallow pools. In our own climate hoar-frost is occasionally produced in June. On the parched plains of Bengal ice is artificially prepared by exposing water at night in shallow vessels to the sky. Thus Jacob, in Scripture, speaks to Laban:—"In the day the drought consumed me, and the frost by night." The history of Gideon's fleece receives support from the copious dew found by travellers on the sides of lakes, rivers, and the sea in Palestine and Arabia. These facts are very illustrative of the rapid radiation from the earth under calm and cloudless skies. Dew and hoar-frost are thus produced.

On undulating ground and verdant slopes the cold air from the inclines collects on calm nights in hollow basins at their feet. The line of contact with the warmer and moister air above is marked by a thin horizontal sheet of fog, producing from above the winding appearance of a river, or the wide and waste appearance of a lake. These radiation fogs, as they are called, are raised and dissipated at sunrise by the heat of the sun, whose rays in their turn produce by day an exactly opposite effect.

Air at the surface of the earth exposed to an unclouded sun becomes charged with heat and vapour. It is rendered buoyant, and rapidly ascends to a height where its excess of

vapour is discharged in clouds. Dome-shaped, cumbrous-looking masses are produced, at a height of 4000 to 8000 feet above the sea, called *Cumulus* clouds, from their pillow-like appearance. At Quito, and at other places on the equator, these clouds first make their appearance in the morning. They increase in size and numbers till the afternoon, and at the same time subside in height until the sky is completely overcast with a species of clouds called *Cumulo-stratus*, from which rain is immediately discharged in torrents. With the disappearance of the sun these clouds subside yet further, and cumulo-stratus then collects itself at evening into horizontal stripes of clouds, called *Stratus* from their level distribution. These clouds only accompany fine and sunny weather peculiar to a dry condition of the air.

In mountainous countries, a great variety of clouds is produced among the upturned currents of the air. The well-known "caps" upon the summits of certain mountain-peaks—for example, the Mam Tor, or Shaking Mountain, in Derbyshire, the Matterhorn in Switzerland, and the Table Mountain at the Cape of Good Hope—give these mountains the appearance of active volcanoes in perpetual eruption. Being driven to visit a higher and a colder level, the currents of wind discharge their moisture for a time, which they again resume on descending the opposite declivity of the mountain. Near to the Table Mountain, a secondary cap is even formed, at a considerable distance, by a secondary ripple of the wind. The influence of mountain-slopes is, however, confined entirely to the precincts of their valleys. This is most apparent in the fact, that some mountain-ranges are subjected to perpetual rain, while the plains in their immediate neighbourhood are free. In Cumberland, from the summit of Skiddaw, three thousand out of five thousand clouds were reckoned by Crossthwaite to occur below the level of the mountain, whose height is 3150 feet above the sea. The remainder, or by far the smaller number, occurred at greater heights. The reverse would probably be observed on the surrounding level land, for there high clouds are the rule, and those of lower elevations the exception.

The loftiest clouds of all are the slender whisps of Cirrus—"mares' tails," as they are generally called—whose streaks occur at heights of more than 20,000 feet above the sea. Cirrus is the natural forerunner of a southerly wind. Should its streaks be tangled, and their edges sharp and well-defined, they give short notice of the coming wind. In general they are diffuse, and Cirrus gradually overspreads the sky with a misty, gauze-like veil, called *Cirro-stratus*. The various appearances of halos, burrs, mock-suns, and mock-moons, are seen in this cloud in perfection, which also gives a

fiery hue at sunset to an apparently cloudless sky. Its height is 15,000 or 20,000 feet above the sea. At a lower and more advanced stage of the southerly current, *Cirro-cumulus* is formed, and the well-known appearance of a "mackerel-backed sky" is produced. Cirro-cumulus is the immediate precursor of the wind, or of rainy weather, according as its outlines appear sharp and oily, or the reverse. It changes by insensible degrees into cumulo-stratus, whose ragged masses sail across the sky, or settle into thick and rainy weather according to the moisture of the air. Between cirro-cumulus and cumulo-stratus, a quantity of fleecy clouds are often found; and in the direct light of the sun, the vivid hues of the mackerel's skin, as described by Sir John Herschel (*Meteorology*), are sometimes reproduced. It also forms a corona of highly-coloured circles round the moon, especially in unsettled conditions of the weather, when a south-west current veers towards the north, and northerly winds are felt along the ground.

A cloud is called *Nimbus*, or rain-cloud (as its name implies), when, from its lower surface, it precipitates rain, snow, or hail. Local clouds of this kind are seen both in mountain-valleys and in the plains, and are never absent when thunder and lightning are produced.

As it is not intended in these articles to enter into practical details, the particular difficulties of rain-guage measurements in connection with this subject, now attracting much attention, must be passed over in silence, and the subject of rain, hail, and snow will be deferred to a chapter on the winds.

In the foregoing paragraphs, a knowledge of the construction and use of simple instruments only has been assumed—such as the different forms of the thermometer. An acquaintance with the standard form of barometer will, in the same manner, be found a sufficient introduction to the subject of the winds. Attention must, however, be paid to two principal corrections of the barometer, without which it fails to indicate the atmospheric pressure. The first of these corrections is that for temperature of the mercury, and of the brass scale (in perfect instruments), as shown by the "attached thermometer." The other is for the height of the instrument above the sea. The height of the mercurial column, "corrected to the freezing temperature of water, and reduced to the level of the sea," represents the pressure of the atmosphere at any place; and observations of this kind can only be consulted for comparison with one another. For this purpose, Lowe's *Barometrical Tables* are extremely useful, and more abundant materials are contained in the *Meteorological Tables*, published by the Smithsonian Institute of America.

AIDS TO MICROSCOPIC INQUIRY.—No. VII.

Hairs of Plants.

It is a very common thing for the possessors of microscopes to neglect objects of beauty and interest which are readily accessible, and thus not to derive from their instruments the pleasure and mental profit they can afford. Those who have even a few square yards of town garden, or who have access to ordinary plants, may derive much gratification from the examination of the hairs of plants.

The hairs of plants are cellular growths springing from the cuticle; so that, if the plant possesses a solid woody stem, the hair, however hard in character, may be entirely removed by pulling away a portion of the cuticle beneath it, and without touching the solid stem. Thus hairs, even when prickly, are distinguished from true spines, such as grow upon holly stems, and remain after all the integuments have been removed. In its simplest form, a plant-hair consists of a single straight tube of small dimensions; but jointed hairs, composed of cell added to cell, in linear prolongation, are very common; and so are hairs of a still more complicated structure, beautifully branched, and presenting star-shaped, or other agreeable, forms.

In vegetable structure we continually notice that certain cells are strengthened by a layer or layers of internal deposits. Cherry-stones, vegetable ivory nuts, and innumerable other substances, are composed in this way. These strengthening deposits may be of a character allied to woody tissue (*sclerogen*), or may consist of mineral matter, such as the silex found in the outer layers of straw, canes, etc. A hair stiffened in this way becomes a bristle, or a stiff scale. Ordinary hairs are soft, delicate structures, with fluid contents, the rotation of which may be seen with a sufficiently high power. Cabbage-leaves offer good specimens of single hairs, conical in form. Beautiful star-shaped hairs cover the leaves of the Alyssum, common in all gardens; and, in fact, plants by the dozen might be named in which the hairs are well worth examination. We shall select a few we have picked from very accessible plants.

First, if we take an ivy-leaf—a young bright green one being the best—and turn it with the under side upwards, we have a beautiful object for an inch or two-thirds object-glass. We see groups of hairs springing from a common base, and stretching out somewhat like the arms of a star-fish. This object should be viewed by reflected light, and then some of the hairs, removed with a portion of the cuticle on the point of

a penknife, can be placed in a drop of water, and examined with a quarter or a fifth as transparent objects.

A young green pod of a sweet pea is another good object. To the naked eye it is obviously hairy, and when a strong light is thrown upon it, and it is viewed with a three-inch objective, the effect is very fine; each hair is seen to rise from what looks like a little globe of crystal, which flashes in the light, and contrasts beautifully with the bright green cells of the peascod. When we take off a little piece of the cuticle with its adherent hairs, and view it with a power of one or two hundred linear, we find that what looked like little transparent globes under the lower objective, are delicate, somewhat conical elevations, composed of many transparent cells, and surmounted each by a long hair.

Another superb low power object may be found in the under surface of a foxglove leaf, thickly set with jointed hairs, amongst which little insects roam, as larger animals do in forest glades.

Our next object of this class shall be selected from an old-fashioned plant, easily obtained, and whose sweet scent preserves its place as a common favourite—we mean lavender. Take a fresh clean leaf of this plant and shave off a little of the down on its surface with a razor or sharp knife. Place the down on a slide in a drop of water, cover with thin glass, and magnify about sixty linear. The hairs are then seen to be beautifully branched in star patterns. With polarized light and selenite object-holder they are elegant objects, lit up with rose and purple light when the prisms are in one position, and shining like silver when they are in another. These hairs are well worth mounting in glycerine jelly or some such material.

Exquisite stellate hairs, strengthened with a silicious deposit, are found on the leaves of the *Deutzia gracilis*, a common green-house plant, covered with graceful white flowers in the spring. They are admirable polariscopic objects, not as well known as the leaves of the *D. scabra*, which is less frequently met with and scarcely more interesting. A piece of the leaf should be mounted in glycerine jelly, or any fluid good for the preservation of vegetable tissues. The effect of polarized light on this object is to give it the appearance of stars formed of coloured gems on a richly tinted ground.

It is very common to find hairs on plants swollen into little globes at their tops, and containing a special coloured secretion. Hairs of this description are called *glandular*, and they often form objects of remarkable beauty. If the flower of the common snap-dragon (*Antirrhinum majus*) is torn open, groups of yellow tipped hairs will be seen on the inside of the corolla. These should first

be viewed without disturbing them, by using a low power, and illuminating them as an opaque object. They will be seen to be tubes terminating in globular heads, and more or less filled with a bright-coloured fluid. A few of the hairs may then be cut off with a fine, sharp pair of scissors, taking a delicate slice of the cuticle of the corolla with them. These hairs, examined under a power of from 200 to 1000 linear, will be found covered with minute elevations all up their tubes and over the expansion at the top. Although the terms cuticle and epidermis are commonly applied to the whole cell-wall of a hair, it will be found that a true epidermis, or outer covering, may be separated by acids from the real skin, if we may use the term. In the case of these hairs, nature seems to have blown out the true epidermis in little bubbles of elongated form, and hence the irregular appearance which their surface presents. Some of these snapdragon corolla hairs are spindle-shaped, and blown out with more or less irregularity. They are all interesting microscopic objects, and the splendid yellow colour of their contents does not seem to be injured by glycerine jelly. Another pleasing object will be found on the stems of the pretty wild flower, "Herb Robert," the hairs of which have exquisite ruby balls at their tips.

The phenomena of cell rotation may be seen in hairs, and Mr. Wenham has traced it in a great variety of plants. It requires careful illumination for its display, and a higher power than suffices for showing the movement of the coloured sap globules in Anacharis or Valisneria. The hairs to be examined should be removed without injuring them, by tearing off a portion of the cuticle from which they spring. They should be immersed in a drop of water, and, if necessary, slightly warmed by blowing hot air upon the covering glass, which may be effected by means of a glass tube heated by a spirit lamp. Dr. Carpenter says "the nature of the movement in the hairs of different species of plants is far from being uniform. In some instances the currents pass in single lines along the entire length of the cells, as in the hairs from the filaments of the *Tradescantia Virginica,* or Virginian spiderwort. In others there are several such currents which retain their distinctness, as in the jointed hairs from the calyx of the same plant. In others, again, the streams coalesce into a network, the reticulations of which change their position at short intervals, as in the hairs of *Glaucium luteum,* whilst there are cases in which the current flows in a sluggish uniformly-moving sheet or layer. When several distinct currents exist in one cell, they are all found to have one common point of departure and return, namely, the "nucleus," from which it seems fairly to be inferred that this body is the centre of the

vital activity of the cell."* This "nucleus" will be easily recognized as a stationary mass of protoplasm.

The interest derivable from these inquiries will be much increased by paying attention to the botanical characters of plants, and observing in succession several members of the same family, noticing both resemblances and differences. Botany is, from its profusion of hard words, a very alarming-looking study; but a very moderate amount of trouble will enable any one to learn enough of the principles of classification to ascertain, with the help of a good book, the family genus, and generally the species to which a plant belongs. It is a bad plan for any one not studying under a good botanist, whose verbal explanations can at once remove difficulties, to begin with costly and elaborate text-books. A simple elementary work, like Spencer Thomson's *Wayside Weeds*,† will form a much better introduction; and when a few easily-obtained plants have been examined as he directs, the student will be prepared to profit by the *British and Garden Botany* of Mr. Leo Grindon,‡ which is the easiest and most convenient book for general reference that has been produced. The works we have named are both cheap, and their possession will greatly augment the quantity of amusement and instruction to be obtained by means of a microscope. The writings of our great botanists, Lindley, Hooker, Babington, etc., will be all the better appreciated if studied after some preliminary knowledge has been gained.

The interest arising from the study of plant hairs will be assisted by a regular method of viewing them. First *in situ*, with a low power, so that their general form, grouping, and situation, with respect to veins, stomata, etc., may be seen. Then a minute examination with higher powers, and lastly the employment of polarized light.

* *The Microscope and its Revelations.* Third Edit. p. 409.
† Groombridge and Sons. 1864. ‡ Routledge.

SUBMARINE TELEGRAPHY.

BY RICHARD BITHELL, B.SC., PH.D.

No attentive observer could spend an hour in the examination of any of the commonly-used electric telegraphs without discovering that there were *three* distinct parts of the apparatus on which the engineer is called upon to direct his energies, and which in turn may task his highest skill. These parts are—

I. A battery—voltaic or magnetic—as a source of electric power.

II. Conducting wires—by means of which the electric fluid is conveyed from one spot to another more or less distant.

III. Instruments—that is, pieces of apparatus; by means of which the action of the fluid on the conducting wire may be made evident to the eye or ear.

Every telegraphic system contains these three parts, and each in turn has been an object of the electrician's profoundest study and most earnest solicitude. In all cases the *first* of these parts is a matter of primary importance, and in the infancy of telegraphic science much difficulty was felt in securing batteries of sufficient power and constancy—the latter quality being essential to the proper working of the system. Owing to the amount of attention and experience which have been brought to bear on this part of the apparatus, batteries of various kinds have been devised, which answer their purposes sufficiently well to meet all the requirements of telegraphy in its present stage of development. In the transmission of currents over long distances however, and especially in marine telegraphy, great difficulties are met with in the construction of the *second* part of the system, namely, the conducting wires—difficulties so great as to offer a wide field of improvement to those whose business or taste may lead them to engage in the study. But in the organization of central stations, and especially in such as have to transmit or receive messages in great number, the *third* part rises into importance, and the question is how to construct instruments which shall communicate signs to the ear and eye with the greatest promptitude, rapidity, and precision. In the observation and consideration of any form of telegraph, therefore, it will be necessary to glance at each of these three portions of the apparatus, while one or the other may claim in turn a greater amount of attention, according to the purpose to which the telegraph is to be applied, or the special object which we have in view.

Telegraphs are commonly, though rather loosely, designated

according to the supposed excellence of one or more of the three parts above named, or according to the purpose for which they are intended. Thus we have Needle telegraphs, so called because their indications are made by the deflections of a magnetic needle; Printing telegraphs, which actually print on a slip of a paper, or other material, the signs or letters indicated; Alphabetical telegraphs, so called because they point to, or print the letters of the ordinary alphabet; Magnetic telegraphs, which derive their name from the motive power, which is a magnetic and not a voltaic battery; Submarine telegraphs, intended to convey signs by means of wires or cables laid at the bottom of the ocean bed, and so forth.

To this last species of telegraph we confine our attention in the present paper; and here we shall find the main interest to lie in the construction of the conducting wire, and its safe submersion in the bed of the ocean; for the difficulties attending the construction of a continuous wire of several miles in length, its perfect insulation, and safe submersion in the bed of the ocean, are so great, that every experiment of the kind is watched with the deepest anxiety by all concerned in its success. We shall not, therefore, stop to examine the source of electric power, or the indicating instruments at each end of the system, it will suffice for the occasion to observe that they are the same as in all other telegraphs in use, and are not likely to affect the success of any undertaking where the continuity and insulation of the conducting wire are perfect. The batteries may be either voltaic or magnetic, and the indicating instruments may resemble any of those ordinarily seen in the room of a telegraph office, but the conducting wire must be specially adapted to the circumstances of each particular case.

Among the circumstances which affect the well-being of a conducting wire in the *submarine* telegraph, the most important are the nature of the *ocean bed,* the action of the *sea-water,* and the attacks of *marine animals.*

First, as to the ocean bed. If the sea-bottom be very uneven, rising here into mountains, and falling there into valleys, a much greater length of wire will be required to reach a given distance than would be necessary if it could be laid down in an even line. So great was the difference in the first cable laid across the Straits of Dover, that when the whole of it was payed out, the shore was not reached, and an additional portion had to be made before a landing could be effected. In the present Atlantic cable 630 miles have been allowed to make up any deficiency which might arise from the same cause, and this will explain what appears to have puzzled some people when they read the account of the submersion of the cable during the past month. The telegrams ran after

this fashion, I quote literally:—"Three hundred and fifty nautical miles of cable were payed out at 12·50 p.m. to-day, and 350 miles were run at 4·50 p.m." Again: "Five hundred nautical miles of cable were payed out at 10·50 a.m. to-day. The distance run was 460 miles." In reading these two telegrams, it will be observed that, in the first case, 350 miles of cable were payed out soon after mid-day, but that it took *four hours* longer before the ship had made the same distance from land. In the second case, we see that at one and the same instant of time, the length of cable payed out was forty miles greater than the distance the ship had traversed—the difference being due to the irregularities of the ocean bed, together with some other deflections from a right line, caused by submarine currents, and the divergence of the ship itself from a perfectly straight course. Moreover, there may be chasms in the sea-bottom not detected by the sounding line, across which the cable would be stretched, in which case the tension of the wires would be such as to render it amenable to many untoward influences.

Supposing, however, that the bed of the ocean is tolerably even, it may yet lie so far below the level of the surface as to offer very serious obstacles to the successful laying down of a telegraph cable. The new Atlantic cable was constructed with special reference to this source of danger. The deepest water to be encountered in its course between Valentia Island and Newfoundland was 2424 fathoms, or little less than 2¼ miles. Now, the weight of the cable in water is about 14 cwt. per mile. Hence,

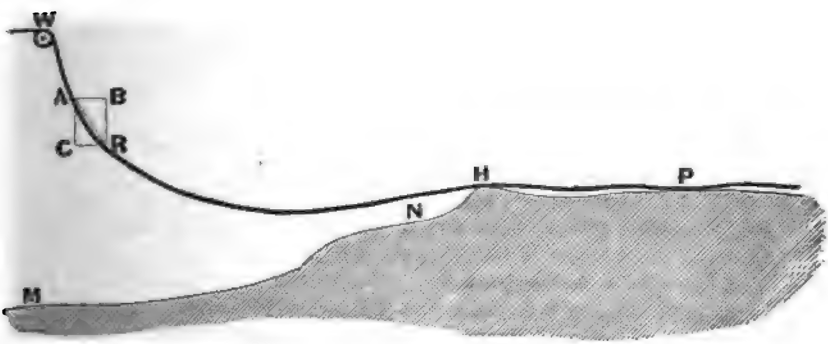


Fig. 1.

if the cable were delivered freely, and fell nearly perpendicular from the stern of the vessel, there would never be a strain of more than about two tons upon the cable during immersion; while the breaking strain which it is calculated to bear is 7¾ tons. But it is not likely that the cable would be paid out so easily

throughout a course of nearly 2000 miles, and irregularities in the sea bottom, such as represented in Fig. 1—though here violently exaggerated—would cause the cable to hang in the form of a curve of greater or less length, according to the freedom with which it was payed out, and the nature of the ground over which it had to pass. The strain upon the cable then would not be the simple weight of the cable itself, but would be compounded of two forces. Let M N P be a section of the sea bottom, H R A the cable, passing over the wheel W at the stern of the ship. Then if A C represent the vertical strain upon the point A, which would vary according to the depth of water, and A B the horizontal strain, varying with the distance of the point of suspension H, the resultant force tending to break the cable would be represented by the line A R, and would of course be greater with every increase of the horizontal strain A B, or of the vertical strain A C; and would invariably be greater than the mere weight due to the perpendicular depth of the cable, which in the diagram is indicated by the line A C. Practically, therefore, it is desirable to diminish the lateral strain, especially in deep water, as far as possible, so as to secure a perfect settlement in the sea bed at as small a distance astern as is practicable; otherwise the strain may be so great as to exceed its "breaking strain."

While speaking of the nature of the ocean bed as affecting the operation of telegraphic wires, it is necessary to notice the action of another force of a most subtle character, one which perhaps may present difficulties when all others have been conquered. We allude to the existence of *magnetic currents* in the earth. The existence of these currents has long been known to physicists, and in the course of time much has been done towards determining the laws of their action. But no means are at present known by which the action of the magnetic force on an electric conductor can be prevented. *Insulation*, which is so effective where electricity alone is concerned, is so powerless when opposed to magnetic action, that glass, gutta-percha, and other insulators scarcely interfere with the action of a powerful magnet more than the air we breathe. Still, it may be fairly expected that the action of "earth-currents," or even of "magnetic storms," will do little more than temporarily interrupt the working of a cable, as they did the working of the terrestrial lines lying between Croydon and the Royal Observatory, Greenwich, on the 3rd, 4th, and 5th of the present month, on which occasion a magnetic storm was experienced more violent than any that had ever been previously recorded.

Passing now from the consideration of the ocean-bed to that of the action of sea-water upon a submerged cable, we

see at once that it will be of two kinds—mechanical and chemical. Both of these have to be specially guarded against. The *mechanical* action arises chiefly from the movement of submarine currents, the direction and extent of which are very imperfectly known to hydrographers. The superficial marine currents, such as the Gulf Stream and others, have been thoroughly explored; and it may be safely inferred, from hydrostatic principles, that where a superficial current exists, there must be, in general, a submarine current somewhere answering to it; but beyond this, little can be stated positively about them. Wherever they do exist in any force, their effect on the bed of the ocean must be very considerable; and if a telegraphic cable should cross the course of such a current, it would be liable to wear and tear, from the attrition of the cable upon the solid rocks, and from the action of the water, which would be often greatly aggravated by its holding in suspension fragments of rocks and mineral débris. As to the *chemical* action of sea-water, its activity is well known; and the iron wires which surround the copper in a cable would stand no chance at all, unless protected by "galvanizing"—that is, covering them with a coating of zinc; or, still further, by "serving" them with tarred hemp.

One might suppose that a cable so protected would be tolerably safe from depredations of every kind. But in warm latitudes, where animal life abounds in the ocean, cables have been rendered quite useless, in consequence of the attacks of these unexpected foes. Nibbling at the hempen covering, they have laid bare the wires, which in turn soon yielded to the corroding influences of the sea-water, and the utter destruction of the cable was the result. In other instances, corals and barnacles have attached themselves to the cable in positions where it has been stretched from rock to rock, when, by their united weight, they caused a strain which the wires could not resist. In more northerly latitudes, there is less to be feared from this cause; nevertheless, as any one who has spent a day at the sea-side has had an opportunity of noticing, there are many molluscs—the *Pholas* and *Limpet* to wit—which possess an extraordinary power of abrading and boring the hardest substances to which they attach themselves; and one never knows how far he is safe from the attacks of such minute and insidious aggressors.

The Atlantic telegraph cable, the object of so much interest at the beginning of the past month, was constructed with due regard to all the difficulties heretofore mentioned, and the manner in which the projectors proposed to meet them can scarcely fail to prove interesting.

In Fig. 2 we have a chart of that portion of the Atlantic

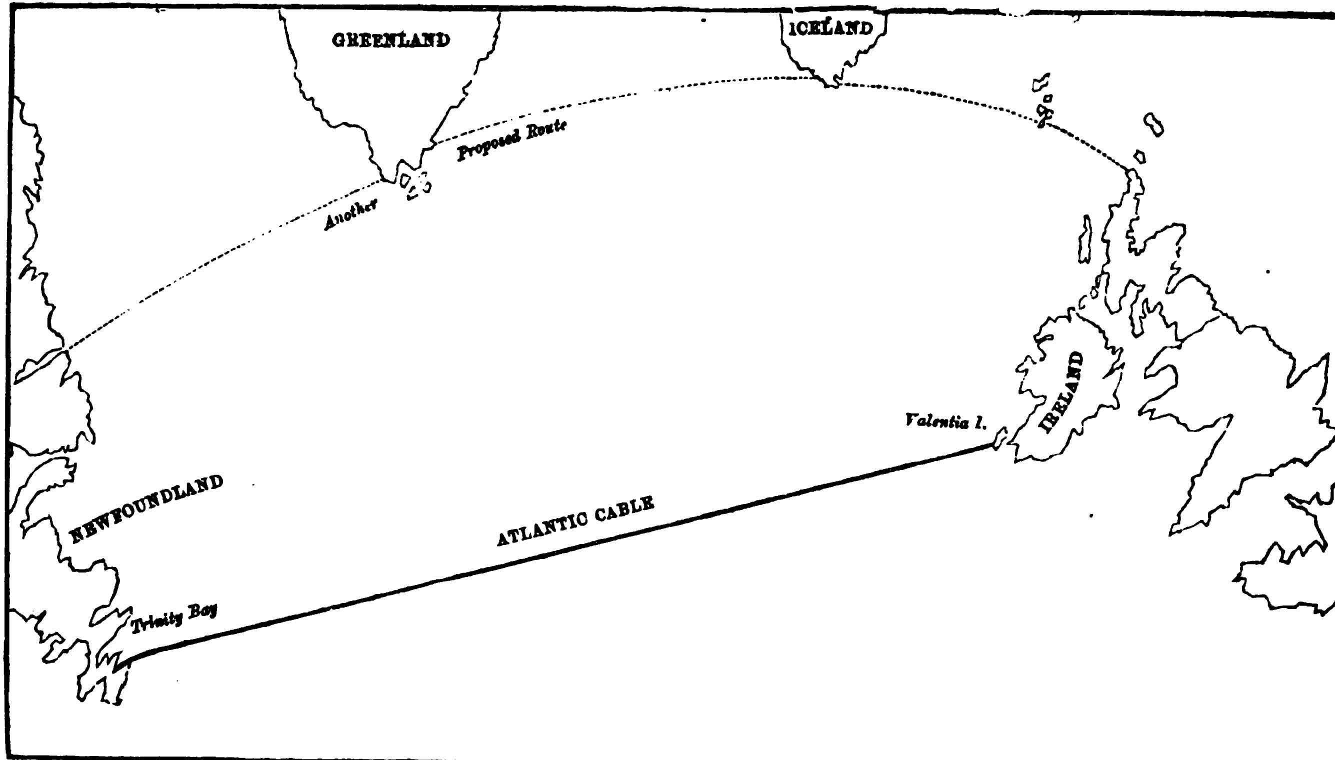

GREENLAND
ICELAND
Proposed Route
Another
NEWFOUNDLAND
Trinity Bay
ATLANTIC CABLE
Valentia I.
IRELAND

Fig. 2.

across which it was proposed to lay the cable. Starting from the most westerly point of the little island of Valentia, just off the coast of Ireland, it took a westerly course to the island of Newfoundland.

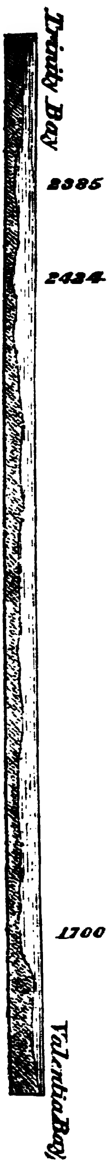


Fig. 3.

Fig. 3 is a section of the bed of the Atlantic, and shows in a certain rough way the nature of the ground over which the cable had to pass.

In fixing on a spot suitable for the landing of the shore ends of a cable, it becomes a question of some importance whether it shall be a *bay* or a *promontory*. If a bold, abrupt promontory be chosen there is a chance of obtaining deep water at a short distance from shore, while, from the nature of the coast, it is the most unlikely place for vessels to cast anchor. As a set-off against these advantages, the waves are apt to be very violent in such exposed situations, and much damage may thereby result to the cable. If, on the other hand, a bay be chosen, we thereby gain the advantage of quieter waters, and sometimes deep ones; but for that very reason it would form an inviting spot wherein to lie at anchor, and the frequent casting of anchors in the neighbourhood of a cable would certainly expose it to great danger. From a consideration of all these circumstances, the balance of advantages appears to be in favour of a quiet bay, when one can be found in which the traffic is not too great; and the little Foilhommerum Bay, on the western coast of the island of Valentia, was selected for the starting point of the late Atlantic cable, with the intention of landing the opposite end in Trinity Bay, on the coast of Newfoundland. A glance at Fig. 3 shows that the ground over which it was to be carried was characterized by depressions and elevations, but of very small amount; for the scale on which the vertical measurements are drawn is here twenty times as great as that of the horizontal, so that the precipitous bank which appears in the section is by no means so formidable in reality as appears in the drawing, while the other undulations of the sea bed are so gradual as to be scarcely visible in a section where the dimensions are drawn both to one scale. The deepest water to be encountered was at a distance of about 1150 miles from Valentia, and indicates, from the mere fact of its depth, the existence of a powerful submarine current in former ages, if not at the present time; while the sea bottom, which is often spoken of

as consisting of ooze, is known to be rocky and rough to an extent that would justify considerable fears for the continued integrity of any cable lying across it.

In order to appreciate the precautions taken with the last cable with a view to guard against a failure similar to that of 1858, a comparison of the two cables may here be made. A longitudinal and sectional view of each is given in Figs. 4 and 5. A glance at these diagrams, which are drawn of the same

OLD ATLANTIC CABLE, 1858.

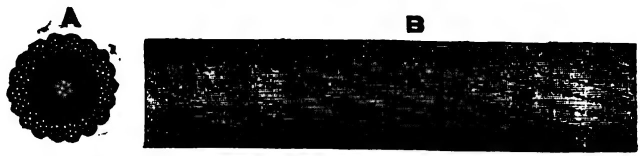


Fig. 4.

NEW ATLANTIC CABLE, 1865.

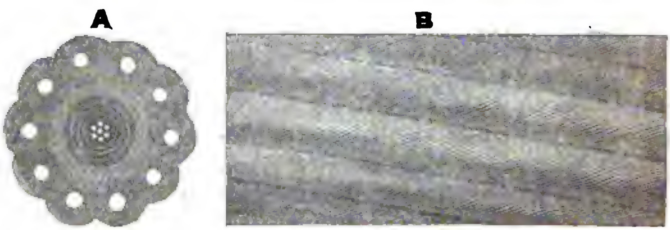


Fig. 5.

diameter as the cables themselves, will at once inform the reader of their respective sizes. The diagram A in each figure is the sectional view, and B a longitudinal. The conductor in each consists of seven wires (six laid round one), but in the cable of 1858 this copper strand weighed 107 lbs. per mile, while that of 1865 weighed 300 lbs., which was embedded for the sake of solidity, and not with a view of insulating the wires from each other, in a matrix of Chatterton's compound. These conducting wires were insulated in the former case by gutta percha, laid on in three coverings, and weighing 261 lbs. per mile; in the latter by four coverings laid on alternately with thin layers of Chatterton's compound, making a weight of 400 lbs. per mile, and bringing up the core to a diameter of nearly half (·464) an inch. For the protection of this essential part the cable of 1858 was surrounded by eighteen strands of iron wire, each strand consisting of seven wires (six round one), laid spirally round the core, the latter having been previously

padded with a serving of hemp saturated with a tar mixture. In the cable of 1865 the core was protected by ten solid wires, nearly $\frac{1}{10}$th of an inch diameter, drawn from Webster and Horsfall's homogeneous iron, each wire being separately surrounded with five strands of Manilla yarn, saturated with a preservative compound, and the whole laid spirally round the core, which latter was padded with ordinary hemp, also saturated with preservative mixture.

The weight of the 1858 cable *in air* was 20 cwt. per mile; that of the 1865 cable was 35 cwt. 3 qrs. per mile. *In water*, the weight of the former was 13·4 cwt. per mile; under the same circumstances the weight of the latter was 14 cwt. per mile. A comparison of these last figures shows that although the latter cable was so much stronger than the former, yet its weight in water was increased by a very small amount. The breaking strain—that is, the strain necessary to break it—in that was 3 tons 5 cwt., in this, 7 tons 15 cwt., and the deepest water to be encountered in each case was 2400 fathoms, or thereabout. The length of cable shipped in 1858 was 2174 miles; in 1865, 2300 miles; and as the total distance from Valentia to Newfoundland was 1670 miles, there were 630 miles available to meet the irregularities encountered in its course.

In addition to the protection above spoken of, the shore ends of the new cable were further protected by iron wires of still larger bulk; so that the entire diameter of the cable with its protective covering was about $2\frac{1}{2}$ inches. This diameter was maintained for the distance of 5 miles, when the protecting wires were diminished in bulk, which bulk they maintained, however, through another five miles; and so on, diminishing every five miles, till, at a distance of about twenty-five miles, the dimensions of the main cable, as above described, were arrived at.

The following is a condensed history of the process of its submersion:—

July 22.—At Foilhommerum Bay, "Caroline" commenced laying the shore end. At 11·30 p.m. completed laying the shore end.

July 23, 4.25 p.m.—Shore-end spliced to main cable on board the "Caroline." At 4·50 p.m. the "Great Eastern" commenced paying out.

July 25.—"Great Eastern" telegraphs that a small fault had been discovered and cut out. Now paying out again. Signals perfect. Weather very fine.

July 26, 6·50 a.m.—Cable paid out 150 miles. 9·50 a.m.—Distance run 150 miles.

July 27, 5·50 a.m.—Cable paid out 300 miles. 9·50 a.m.—Distance run 300 miles.

July 28, 9·50 a.m.—450 miles run. 10·50 a.m.—Cable paid out 500 miles.

July 29, 6·50 a.m.—Cable paid out 650 miles. 8·50 a.m.—Distance run 600 miles. *Evening.*—Accident to cable. Cause unknown. Total loss of insulation; no information from or communication with ship.

July 30, *morning.*—All going on well. Fault removed. 1·50 a.m., insulation perfect. 4·20 p.m., cable paid out 750 miles. Distance run 650 miles. Continuity and insulation perfect. All going on well.

July 31, 7·50 a.m.—Distance run 750 miles. 1·50 p.m.—Cable paid 900 miles.

Aug. 1, 9·50 a.m.—Distance run 900 miles. 10·50 a.m.—Cable paid out 1050 miles.

Aug. 2, 6·50 a.m.—Distance run 1050 miles. 7·50 a.m.—Cable paid out 1200 miles. 8 p.m.—Signals from ship unintelligible at noon to-day. No communication with or information received from ship since. Cause unknown.

Aug. 3, 11·30 a.m.—No information received from ship. Cause unknown. No communication with ship.

* * * * *

From this date up to the morning of the 17th of August no intelligence of any kind was received from the ship. On the morning of that day, the "Great Eastern" was sighted off Crookhaven, and a few hours afterward was telling her story to thousands of waiting ears. But as the story involves frequent mention of "testing," "grappling," and "hauling," terms having a much more refined application than is commonly assigned them, we will wait in hope of another opportunity of bringing a full description of these processes before our readers.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from Page 374, Vol.* vi.)

1338. On April 15, a comet was discovered. The sun being then in Taurus the comet was at the beginning of Gemini. Its movement was from W. to E. with a declination increasing N. It followed the sun and set about midnight. On April 17, it was in 24 or 25° of Gemini. From a note by Friar Giles, it appears that its latitude was then 17° or 18° N. It remained in sight a fortnight or more.—(*Chronicon Rotomagense.*)

1340. On March 24, a comet was discovered, whose R. A. was 12° greater than π Scorpii. "When first seen it was in the latter part of Libra; then it retrograded at the rate of 5° a day, till it came to Leo, when it disappeared." It was visible thirty-two days.—(Gregor. *Hist. Byzant.* xi. 7, 5; De Mailla, ix. 576; Gaubil.)

1345. At the end of July, a comet appeared near the head of Ursa Major. It advanced, day by day, to the Zodiac, and when it reached the latter part of the sign Leo, where the sun was, it disappeared.—(Gregor. xv. 5, 6.)

1347. In the last year of the reign of Louis of Bavaria, a comet appeared for two months. In Italy it was only seen during fifteen days in August, in 16° of Taurus, in the head of Medusa.—(*Chronicon Nuremburgense.*)

1356. On September 21, a comet was seen in 17° 10′ of the constellation *Tchang* (φ, γ, λ, υ, κ Hydræ), it remained visible till November 4.—(Gaubil.) When discovered it was as bright as Regulus (α Leonis).—(Biot.)

1360. A comet was seen in the E. for a few days, from March 25.—(*Chronicon Zwetlensis*, De Mailla, ix. 633.)

1362. [ii.] On June 29, a comet was seen in the circumpolar regions with an R.A. 2° 90′ (qy.) greater than β Capricorni.—(Biot says 9·9°.) It went to the S.W., and on August 2 had disappeared, having lasted six weeks. Its tail was one foot (or degree) long.—(Gaubil; Pingré, i. 440.) De Mailla says that the comet appeared near α and β Aquarii, and that its tail was more than a *hundred* feet long.—(*Hist. Gén.* ix. 640.) This account is altogether irreconcilable with Gaubil's. Can there have been *three* comets this year, or does not De Mailla rather refer to the first comet, whose orbit has been calculated, and therefore appears elsewhere?

1363. On March 15, a comet appeared in the E. for a month.—(Biot.)

1368. In February, March, April, a comet appeared in the evening, in the W. or N.W., to the N. of the Pleiades.—(Couplet; Walsingham, *Historia Anglica.*) On February 7, a comet was seen between the divisions of the Pleiades and Hyades. On April 7, a comet was seen in the N.W. between τ, κ. ρ, and α, γ, η Persei. The tail was 8° long, and pointed towards θ Ursæ Majoris. It ultimately disappeared to the N. of α and β Aurigæ.—(Biot.)

1371. On January 15, a very great comet was seen in the N. Its tail was directed towards the S.—(Bonincontrius, *Annales.*)

1373. In April, May, three comets entered the circle of perpetual apparition.—(Biot.)

1376. On June 22, a great comet appeared in ι, θ, η Ceti; it traversed δ, ϵ, μ, ν Piscium, ν Persei, entered the circle of perpetual apparition, swept θ, v, ϕ Ursæ Majoris, and directing itself towards δ, ϵ, π, ρ Draconis, entered the sidereal division of ν^2 or 39 Hydræ. It disappeared August 8.—(Biot; Gaubil.)

1380. On November 10, a comet appeared.—(Cygnæus, *Chronicon Citizense.*)

1382. [i.] On March 30, a comet appeared.—(Bothonis, *Chron. Brunswicensis.*)

1382. [ii.] On August 19, a comet appeared in that part of the heavens where the sun sets in June. It lasted for fifteen days, and was seen two hours before sunrise, though these two latter statements may be open to doubt.—(*Annales Vicentini.*)

1382. [iii.] In December, a comet appeared in the W. for more than a fortnight.—(Walsingham, *Historia Anglica.*)

1388. On March 29, a star came from the division γ Pegasi.—(Biot.)

1391. In May, a small comet appeared near the stars of Ursa Major. Its tail was not very bright.—(*Annales Forolivienses.*) Biot says that two comets appeared on the twenty-third of this month. One entered the circle of perpetual apparition, between α and ι Draconis, and passed to the S. of θ Draconis, and the other passed by the N. of Camelopardus, and swept the pole-star.

1399. In November, a star of extraordinary brilliancy was seen; its tail was turned towards the W. It lasted only a week.—(Mezerai *Histoire de France.*)

THE CATTLE PLAGUE AND SCIENTIFIC INVESTIGATION.

The excitement caused throughout the country by the prevalence of the typhoid disorder popularly called the "cattle plague," has not induced a state of mind very favourable for accurate scientific investigation; and yet it is impossible to read the reports of speeches delivered in various districts without perceiving the urgent need of a rigid inquiry. In the absence of accurately collected facts and cautious reasoning we are likely to be afflicted with an epidemic terror, capable of doing more mischief than the disorder that has given rise to it. It is especially the fashion of the hour to assail the foreign cattle trade, and to set up the most violent theories of contagion, infection, etc. Those who are familiar with social history will see in these incidents only a repetition of what has often occurred before, and what has been demonstrated to be unreasonable, whenever it has been adequately investigated. No one doubts that a very minute quantity of matter in particular conditions is capable of setting up disease in appropriate subjects; and questions of contagion, infection, etc., really resolve themselves into inquiries concerning the action of infinitesimal doses of poison conveyed by divers methods into the organization of living beings. The surgeon puts a small quantity of his vaccine matter into the arm of an infant, and he thereby sets up a morbid action. The mad dog inserts a probably smaller quantity of a more virulent poison into the body of his victim, and fatal results often ensue. A pestilent marsh gives off in its vapours and exhalations a minute quantity of some matter that has escaped the chemist's investigation, and which may exist in quantities too minute for his analysis. This morbific matter is breathed for a short time by one passing through the swamp, and he carries away with him a supply of some sort of ague that may last for the remainder of his days. In such cases, and in others that might be easily imagined, we have a transfer of a more or less infinitesimal portion of matter in a particular state, from the situation in which it originated, to some other situation in which it excites chemical or other actions hostile to health and life.

It concerns not our present inquiry whether the poisonous matter be itself organic, as in the case of fungoid or other microscopic vegetation, or whether it be merely a complex compound undergoing changes by which it is able to excite analogous changes in the complex compounds of which the soft and fluid parts of living creatures are composed.

The ultra-contagionist or infectionist goes to the greatest lengths of his imagination in ascribing deadly qualities to the most minute and diluted quantities of the sorts of poison which are under consideration. His opponent, without denying that exceedingly minute quantities of certain substances can excite disease, contends that, with due precautions, actions of contagion, infection, etc., may in many cases be so minimized as to be practically harmless, while in another class of instances, in which the poison appears to be diffused over large areas by atmospheric currents, he sees the futility of attempting to exclude is by measures of quarantine.

Wo shall select an instance of infection run mad from the proceedings of the College of Physicians in 1831, when the Asiatic cholera frighted these isles from their propriety, and when no less a person than Sir Henry Halford presided over the august body that took the lead in talking nonsense and exaggerating alarm. In opposition to the more mature opinion of the physicians of Bengal, the medical board over which Sir H. Halford presided declared that plans for keeping out cholera by quarantine had been found effectual. They then recommended the following truly insane measures:—

"To carry into effect the separation of the sick from the healthy, it would be very expedient that one or more houses should be kept in each town, or its neighbourhood, as places to which every case of the disease, as soon as detected, might be removed, provided the family of the afflicted person consent to such removal; and in case of refusal, a conspicuous mark SICK should be placed in front of the house to warn persons that it is in quarantine; and even when persons with the disease shall have been removed, and the house shall have been purified, the word CAUTION should be substituted, as denoting the suspicion of the disease; *and the inhabitants of such house should not be at liberty to move out or communicate with other persons until by authority of the local board the mark shall be removed.*"

The next paragraph of this singular medical document recommended that persons dying of cholera should be buried in a detached ground near the house in which they perished, and that "*all persons who may be employed in the removal of the sick from their own houses, as well as all who may attend upon cholera patients in the capacity of nurses, should live apart from the rest of the community.*" So violent was the mental disorder at this time afflicting the College of Physicians, that they did not stop at the absurdities we have cited, but advised "all articles of food, and other necessaries required by the family, should be placed in front of the house, and received by one of the inhabitants of the house after the person delivering them

shall have retired," and that convalescents, and all in communication with them, should be kept under surveillance for twenty days. Further than this, the local magistracy was invoked to stop intercourse with infected towns; and if the disease assumed the terrific form known on the Continent, the philosophical guardians of the public health declared, "*it may become necessary to draw troops, or a strong body of police, around infected places,* so as utterly to exclude the inhabitants *from all intercourse with the country.*"

We leave to medical science the task of deciding whether the learned body from whom this rubbish emanated was suffering from some form of *hysteria,* but in tracing the facts of the time it would appear that, from want of due sanitary precautions, their complaint was communicated to the "King in Council," who published their recommendations in form of an "Order." Happily their disorder did not become epidemic, and the people declined to be as foolish as their learned advisers wished. Very absurd things were, however, submitted to; and, amongst other ridiculous regulations, communication between London and Edinburgh was *prohibited by sea,* lest the cholera should travel in the same ship; but *permitted by land,* as the authorities had a notion that it would not take passage by the old mail coach!

It is obvious that an immense amount of poverty, misery, disease, and death would have been the result of carrying out all the insane recommendations of the College of Physicians of that day. Business would have been at a stand-still, wages and profits temporarily abolished, abject and unmanly terror would have seized possession of the land, and we should soon have realized the condition imagined by the poet, in which "darkness" might have been "the burier of the dead." If we endeavour to ascertain why a grave and learned body of fairly able men propounded so much perilous nonsense in the most solemn good faith, we shall first observe the tendency of terror to spread by what we may be permitted to call mental contagion. Secondly, we shall see the mischievous effect of an undue and unphilosophical reverence for authority. Extravagant doctrines of contagion and infection had come down to the medical schools from the middle ages, and only a few great thinkers, like the late Southwood Smith, ventured to doubt what it was considered sound orthodoxy to believe. There was, in the third place, a remarkable want of *verification,* a process which Mr. Lewes, in his *Life of Aristotle,* shows to have been neglected by the ancient world, and which the moderns too frequently fail to employ.

One of the noblest contributions to recent literature, Mr. Grote's *Plato and other Companions of Socrates,* is full of apt

illustrations of the value of negative inquiry. He shows most forcibly that investigation is not only useful for the discovery of truth, but also for the purpose of ascertaining the real bounds of knowledge, and of learning the precise force of reason that can be alleged in favour of any particular proposition that authority recommends.

If the College of Physicians, in 1831, had felt the logical and scientific necessity of negative inquiry and verification, they would not have so completely stultified themselves. They accepted upon authority doctrines which inquiry would have greatly modified, and they assumed propositions to be correct which were known to be incorrect by other persons better acquainted with the case.

We have only to read the daily papers to see that the frame of mind in which the College of Physicians proved a misguider of those who believed in them, is now more or less prevalent in many quarters, and were the doctrines and opinions of the ultra-cattle-contagionists acted upon, we might expect a great rise in the price of meat, as the result of a violent interference with trade.

We are far from contending that the Government should be inert in such a crisis, but certainly one of its primary duties is to collect and arrange facts so as to know what it is about. If every cow from foreign parts is to be treated as Sir H. Halford and his colleagues proposed to treat every individual who had intercourse with a cholera patient, the interference with the import trade of cattle will be vexatious and mischievous in a high degree. If every cow suspected of the disease is to be at once killed, a needless destruction of stock must take place, and if farmers and others are taught to believe in the extremest form of the contagion and infection theory, it is difficult to see how they can shape their conduct by rational rules.

It is not likely that disorders affecting cattle differ materially from those which affect human beings, and though the records of epidemics point most clearly to measures of caution and prudence, they do not justify the sort of alarm of contagion which runs through most of the speeches we now read.

The Board of Health Reports on Quarantine abound in illustrations of the fallacy of particular arguments, set up at various times and in various places, concerning the importation of disease and the force of contagion. We have seen how strong was the belief in the professional mind of the contagious character of cholera, and yet that has passed away under the influence of a more accurate observation of fact. In like manner it was imagined that quarantine was necessary and

successful in stopping the spread of yellow fever, and yet the evidence published by the Board of Health in the second of the Reports* to which we have alluded, tells precisely in the opposite way. "During the late epidemic of British Guiana," says Dr. Blair, "the yellow fever cases in their worst forms were never separated from other patients in our hospital wards. Such a thing was not deemed necessary, and was never thought of .... Our hospital nurses never got infected, although in the closest connection with the sick, and often smeared with their ejections .... The resident surgeons, dispensers, and stewards were all susceptible subjects, and with one exception escaped without attack."

It by no means follows that because this sort of evidence might be multiplied to any extent with reference to cholera, yellow fever, and certain other disorders, a similar investigation would terminate in the same way if the cattle plague were the subject of scientific inquiry, and as our purpose is to enforce a scientific method of investigation, we do not wish such information to go for more than it is worth. The cattle plague *may* possess powers of contagion greater than any known disorder, but plenty of other disorders have been spoken of in the same terms, and we do not recollect a single case in which the alarm of contagion has not been diminished when an epidemic has been studied in a scientific way.

This tendency of inquiry to reduce fear is exemplified in the course of opinion on the cattle plague. At first the ultra-contagionists seemed to have it all their own way, though some cautious authorities like Professor Varnell immediately pointed out the probability of their mistake. At the time we write Professor Dick of Edinburgh has expressed similar views, and several letters from agriculturists tend to diminish alarm. Important practical opinions on the question are also given by a cow and a calf at the Royal Veterinary College, who for a month past have not availed themselves of their alleged opportunities of catching the disease, which has carried off seven or eight of their companions in the very next sheds.

The want of air, light, and ventilation in many, perhaps we might say, most cattle sheds and dairies, supplies conditions remarkably favourable to the generation and spread of disease, and the wonder is that loss from such causes is not greater than we are accustomed to, and to these constant sources of danger we may add the prevalence of hot, moist weather, which has exerted a depressing influence upon men and animals.

The materials for forming opinion exist in unhappy abundance with reference to the cattle plague; but the public are not in possession of an adequate number of verified cases to

* 1852.

be able to judge of the real extent of the danger and the best mode of averting it. It would be well if the Government "improved" this occasion by making better preparations for the future. There should be a constant collection and classification of what Bentham called "pre-appointed evidence," that is, evidence ready to assist inquiries likely to be made and worth making. The sifting and verification of evidence of this class is a difficult task. The medical man must be relied upon for the detection and naming of the disease, but as soon as he begins to form a theory of the mode of its introduction or propagation, he cannot lay claim to any special authority, as there is nothing in his education or habits that peculiarly fits him for rigid logical inquiry. The highest class of scientific men—medical included—are able and cautious reasoners—more given to wholesome doubts and processes of verification than ordinary persons. Such men are necessarily rare; but when the occasion is sufficiently important, it is in the power of the State to secure their aid.

If the cattle disease lasts till Parliament assembles, proposals for investing the Government with fresh powers will be sure to be made. It is natural that in a matter of so much moment and difficulty the intervention of the State should be invoked; but it will be incumbent upon the Legislature to sift the evidence that may be adduced in the most cautious way. By collecting accurate information, and spreading it, the Government may be sure to do good; but if it relies too much upon measures differing materially from those of general sanitary precaution, it may do much harm. Mr. Arthur Helps, the Secretary to the Privy Council, states that "it does not appear that in countries where the Government possesses the amplest powers for dealing with cases of this kind, and where they have exercised those powers with great vigour, any signal success has attended their measures." This is a very important statement, and the evidence upon which it is made should be most carefully weighed. That it is correct, we think most probable; but if so, much of the ground for State intervention is cut away.

The most safe course for the Government is to be very moderate in restrictive enactments, and to rely chiefly upon its power of usefully influencing opinion, by collecting the best information, and subjecting it to the scrutiny of the ablest men.

We have now a well-educated body of veterinary surgeons, upon whom considerable reliance may be placed; but, to utilize their labours, they must be treated in a scientific manner, and great pains taken to discriminate between their *bonâ fide* observations of *fact* and the habit they possess, in common with other mortals, of mixing hypothesis with the record of

phenomena. A rigid observation and description of fact is one of the most difficult arts for a man to acquire, and few are the minds that keep a due balance of their powers when an epidemic excitement tends to give undue force to wonder and imagination.

CELESTIAL PHOTOGRAPHY.—ENGELMANN ON DOUBLE STARS.—CRIMSON STAR.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

In a recent number of the Intellectual Observer an account was given of Dr. Draper's Great Reflector with a silvered glass speculum 15½ inches in diameter, intended chiefly for the purpose of celestial photography. We now propose to give some details as to the mode of its application.

The first photographic picture of the Moon appears to have been taken by his father in the year 1840, when a Daguerreotype image was obtained by a 20-minutes' exposure, Daguerre himself having failed in a similar attempt. This experiment was made by means of a heliostat, or apparatus for reflecting the incident rays always in one direction, notwithstanding the motion of the body whence they flow. Dr. Draper, jun., has preferred an arrangement in which, the telescope remaining fixed, and the lunar image being allowed to pursue its own course, the collodion plate is caused to follow its path accurately by means of an appropriate moving power. Mr. De la Rue first suggested this ingenious mode of counteracting the earth's diurnal motion, and it has been carried into effect by the Earl of Rosse; but the mechanism employed by Dr. Draper was devised independently by himself and his brother. An attempt to move the slide carrying the collodion plate by means of screws turned by hand failed from the communicated tremors. A "sand-clock" which was substituted as prime mover, and which caused the frame to slide along two rods, answered much better, but an ingenious contrivance by which rolling was substituted for sliding friction was a still greater improvement, and admitted of the image being followed steadily for nearly four minutes, though fifty seconds were all that was ever found necessary. Two cross lines traced on ground glass are used as a preliminary guide in order to fix the direction of the apparatus parallel to that of the moon's motion, and when a lunar crater stands steadily on their intersection for twice or thrice the period required for exposure, the adjustment is

complete. Excellent photographs were taken by means of a slide thus supported, and driven by the "sand-clock," which consisted of a weight supported by a column of sand allowed to escape through an orifice whose dimensions were variable at pleasure to suit the required rate: and this arrangement was found superior to mercury-clocks and air-clocks, which had been tried in great variety. In fact, Dr. Draper expresses his belief that no prime mover is more suitable than a sand-clock for purposes where steady motion and a large amount of power are demanded. "The precision," he says, "with which such a sand-clock goes, may be appreciated when it is stated that under a power of 300 a lunar crater can be kept bisected for many times the period required to photograph it." Some precautions are however requisite, as might be expected, to secure accuracy of rate. The tube containing the sand should be "free from dents, of uniform diameter, and very smooth or polished inside. Water must not be permitted to find access to the sand, and hygrometric varieties of that substance should be avoided, or their salts washed out. The sand should be burned to destroy organic matter, and so sifted as to retain grains nearly equal in size. The weight, which may be of lead, must be turned so as to go easily down the tube, and must be covered with writing-paper or some other hard and smooth material, to avoid the proneness to adhesion of sand." He found, however, that these columns of sand were frequently liable to minute vibrations, which caused want of sharpness in the enlarged photograph, and an ingenious experiment was tried to obviate these, by substituting metallic for natural sand. The former may be prepared by melting lead with a little antimony, and shaking it while cooling in a box containing some plumbago, the effect of this being to solidify it in the form of a fine powder, about five times as heavy as sand, which only requires sifting to secure uniformity of size: when allowed to escape through a small tube, its flow is "entirely different from that of sand, looking as if a wire or solid rod were descending, and not an aggregation of particles." It would probably have answered better than sand, but the experiment was pushed no further, as a trial of a water-clock or clepsydra proved perfectly successful. This consists of a vertical cylinder with a water-tight piston, which carries at its top a 5lb. weight to move the sliding plate-holder; the lower end of the cylinder being terminated by a stop-cock, to regulate the escape of the water. There is also another stop-cock in a pipe proceeding from the lower part of the cylinder, through which, independently of the first stop-cock, when the piston is raised, the cylinder fills itself with water from a vessel underneath. This might of course be accomplished by a single stop-cock, but the object

of the second is to allow the first to remain undisturbed when its position gives an accurate rate, and the cylinder has become empty.

The great impediment to the production of uniform movement by such an apparatus is, of course, that as the amount of superincumbent pressure determines the rapidity of the escape of the water, and the consequent descent of the weight, this force is continually decreasing with the diminishing quantity of water in the cylinder. In Dr. Draper's clepsydra, this defect is remedied in the following manner. The plug of the principal stop-cock is not perforated by a round hole as usual, but by a slit, which reduces or augments the flow of water through it in a more uniform ratio. To the handle of the stop-cock is attached a strong rod in a vertical direction, reaching up the outside of the cylinder, and pressed by a spring against an excentric attached to the side of the cylinder, so that the turning round of this excentric regulates the movement of the stop-cock with great precision and delicacy, and the rating requires only a few moments. The position of the rod is shown by a divided arc. "Although it may be objected," Dr. Draper says, "that this contrivance seems to be very troublesome to use, yet that is not the case in practice; even if it were, it so far surpasses any prime mover that I have seen, where the utmost accuracy is needed, that it would be well worth employing."

It seems very próbable that an arrangement similar in principle to either the sand-clock or the clepsydra might be employed to supply a cheap and convenient driving power for equatorially-mounted telescopes. Those who have been habitually subject to the annoyance of the rapid motion of an object through the field of a deep eye-piece, will readily appreciate the comfort and pleasure of using a driving apparatus which, by causing the telescope to follow the apparent motion of the heavens, keeps the object immovable in the centre of the field; and contrivances to effect this object, which is especially desirable for micrometric purposes, have been in use for a considerable time. There is more difficulty in accomplishing this point than might be apparent to a novice, from the circumstance that no reciprocating motion—such as that of a pendulum or balance-wheel—is admissible, because it causes the whole wheel-work to move by jerks, which would not only be perceptible but very annoying under the magnifying power of the eye-piece. Flies, therefore, such as are used in the striking train of a clock, or the mechanism of a musical box, have been adopted to act upon the resistance of the air; and these have been made capable of regulation by varying the position of the vanes at pleasure, or causing them to dip more

or less beneath the surface of oil or mercury. But these contrivances involve an expensive train of wheel-work, and it seems likely that one of Dr. Draper's prime movers would be found to answer with a much more simple arrangement; and it is on this account that they have been here described with so much detail, since they appear well worthy of the attention of the possessors of equatorial instruments.

In solar photography, the very short exposure required is secured, as on this side of the Atlantic, by a movable shutter, drawn by an india-rubber spring; this acts with such rapidity, that "the wavy appearance produced by atmospheric disturbance is not unfrequently observed sharply defined in the photograph, though these aerial motions are so rapid that they can scarcely be counted." To avoid this very short exposure, many experiments were made with an unsilvered mirror, reflecting, according to Bouguer, only 2½ per cent. of incident light; but the plan had to be abandoned, from the change of figure and focal length immediately resulting from exposure to the sun. It was found that a glass mirror, though only resting on a few points, can be raised to 120° Fahr. by putting it in the sunshine on a hot day. An unsilvered "flat," or plane mirror, was found to answer better. But the ingenious inventor considers that the "best means of acquiring fine results with solar photography would be to use the telescope as a Cassegrainian, and produce an image so much enlarged, that the exposure would not have to be conducted with such rapidity."

Dr. Draper found that the pinholes, coarseness of granulation in the reduced silver, liability to stains and markings, and spots produced by dust, which assume an offensive importance in enlarging the portrait, were all avoided by washing off the free nitrate of silver from the sensitive plate before exposing it to the light, and again submitting it to the action of water, and dipping it back into the nitrate bath before developing: the quantity of nitrate of silver, however, necessary to development when pyrogallic acid is used, he says, is better procured by mixing it, as usual, with the acid. His nitrate bath contains 40 grains to the ounce, and is acidified till it reddens litmus paper. Focussing takes place on the sensitive collodion itself, the actinic rays being cut off by a yellow glass just in front of it. A pasteboard screen is then placed in front of the telescope, and the yellow glass taken out; and after a lapse of twenty seconds (to obviate, presumably, any accidental tremors), the screen is removed for the operation. He developes with protosulphate of iron 20 grains, acetic acid 1 drachm to the ounce; and intensifies, if necessary, with pyrogallic and citric acid each ¼ grain, nitrate of silver

$\frac{1}{16}$ grain, water 1 drachm (this part of the process is never employed by Mr. De la Rue). Protochloride of palladium, he found, would increase the intensity of a negative sixteen times without any injury to the image, or the production of markings, and is only kept out of general use, he says, by the scarcity of the metal.

The shortest exposure was one-third of a second, the moon being twenty-one days old, but the sky singularly clear. The full moon would, under such circumstances, have required a much shorter exposure, the focal image being exceedingly brilliant. Occasionally, however, a reverse condition of the sky obtains for a month or six weeks, at least in America, when the pale-yellow moon emits non-actinic rays. This, which occurs in very dry weather, Dr. Draper is disposed to refer to dust in a state of minute division. In such a condition of air, the full moon depicted itself with only moderate intensity in twenty seconds; that is to say, forty times as long as usual.

The enlargement of the picture is effected by means of a concave mirror of 9 inches aperture, and 11½ inches focus (for parallel rays), worked to an elliptical figure of 8 feet distance between the conjugate foci, and intended to magnify seven times. At first the negative was illuminated by diffused day-light, and the entire aperture of the mirror used; but the whole image was not reproduced equally sharp in every part. Subsequently, by means of a heliostat, a solar beam 1½ inch in diameter was passed through the negative to the mirror, a little on one side of its vertex, and reflected back on the sensitive collodion plate at a distance; and it was found that, when so small a portion of the concavity was employed, an exact correspondence of the conjugate foci with theory was not demanded, and the mirror performed equally well, whether magnifying seven or twenty-five times. He has even succeeded with a photograph of the moon 50 inches in diameter, which has, as might be expected, a very imposing effect.

Dr. Draper adds some remarks on microscopic photography, in which the employment of a cell of ammonio-sulphate of copper proved very successful. This deep blue liquid was found by his father to have the property of transmitting only the more refrangible rays, with the advantage of a much larger beam of illuminating light without burning delicate objects, and also of much higher powers; and thus in 1856 they obtained excellently defined photographs of frog's blood-discs, Navicula angulata, and several similar objects, under a power of 700 diameters.

When our readers find that on some nights as many as seventeen lunar negatives were taken, most of which were

worthy of preservation, and that not less than 1500 were made in 1862 and 1863, they will form some idea of the extraordinary amount of perseverance which has been brought to bear by Dr. Draper upon this interesting object, as well as of the uncommon fertility of invention and resource which are apparent throughout his very striking and valuable memoir.

ENGELMANN ON DOUBLE STARS.

During the course of last year Dr. R. Engelmann, the observer at Leipzig, completed his measurements of 48 double stars with the 12 feet equatoreal of 8 inches aperture (Paris measure), which Steinheil, of Munich, has recently erected in that observatory. It may be interesting to our astronomical readers to be made acquainted with his results, and those of other observers cited by him, so far as they relate to the objects already described in our Double Star List, of which we shall adopt the order and numbering.

1. ζ *Ursæ Majoris.* The components of this fine pair are still relatively stationary.

4. α *Geminorum.* 5″·526. 242°·86 (1864·16).—Dembowski gives 5″·381. 241°·66 (1863·03).—Secchi, 5″·368. 245°·13 (1855·82).—The change of angle is very apparent, and in a few years we may hope for a more satisfactory determination of its period.

5. ζ *Cancri.* Engelmann could not divide A and B (the close pair), and speaks doubtfully even of the direction of the elongation. For $\frac{A + B}{2}$ and C (that is, for the distance and angle between C and the centre of the compound mass of A and B), he gives 5″·49. 141°·3 (1864·31).—Demb., 5″·477. 140°·56 (1863·05).—Secchi, 4″·929. 141°·2 (1855·19). The angle is evidently changing more than the distance. It seems rather singular that the large aperture of the Leipzig achromatic (8½ English inches) should have failed to deal with the close pair: but from some optical imperfection it evidently gives too large star-discs, 0″·7 to 1″ for 3 or 4 mag., so that it will only elongate γ^2 *Andromedæ,* which Dembowski could frequently separate with an inch less of aperture. In this instance Steinheil's work must be pronounced inferior to that of Merz. My Clark, too, has obviously a great advantage in proportion to its size, as, with only 5¼ inches, 450 *almost* divided ζ *Cancri,* when it must have been still closer, 1865·17. But the superior action of a really parabolic speculum on this class of objects was fully proved a little afterwards (1865·27), when with 8 inches of silvered glass, wrought by Mr. With to a focus of only 6 feet, I saw with a power of about 300 an

unmistakeable black division between the two minute discs of A and B, though, according to Mr. Dawes, their central distance was then only 0″·63. Steinheil has asserted, in explanation of this defect in separating power, that the magnitude of the spurious discs of stars depends not only upon the intensity of their light, but also upon the proportion of aperture to focal length, which is small in the Leipzig telescope. Airy, however, has shown that, from the undulatory theory of light, this magnitude must depend solely upon amount of aperture, without reference to focal length; and Dawes, speaking from an experience admitting of no appeal, affirms that practice is in accordance with theory.

8. γ *Virginis.* 4″·03. 348°·27 (1864·48). The latter measure is, perhaps, he observes, too large. He also states that both stars appear somewhat variable; and hence results the difference of his position-angle from those we formerly gave. These will be brought into harmony with it by adding 180°, which is equivalent to reversing the order of brightness; the more brilliant component being always chosen as the centre of measurement. Demb. has the same estimate. His data are 4″·085. 345°·9 (1863·33).

15. 51 *Libræ* (alias ξ *Scorpii,* entitled by Engelmann ξ *Libræ*). He failed in separating A and B, noting an elongation towards 15°, June 19; 350°, July 22. Demb., too, could only *wedge* it, but with measured angles of much greater consistency. This must be a fine test for the largest class of instruments, though unfortunately at rather a low elevation—10°·55′ S.D.—For $\frac{A + B}{2}$ and C, Engelmann gives 7″·41. 68°·95 (1864·48).—Demb., 7″·154. 70°·46 (1863·12).—Secchi, 7″·503. 70°·47 (1855·54).—Struve, 6″·75. 78°·6 (1825·48). There is evidently angular motion in this star.

20. ξ *Boötis.* 5″·32. 303·°4 (1864·46).—Demb., 5″·59. 303°·03 (1863·15).—Secchi, 6″·017. 310°·05 (1856·88). Hence its rapid motion is evident both in angle and distance.

22. ζ *Boötis.* 0″·87. 306° (1864·5).—Secchi, 0″·995. 305°·7 (1855·7).—Struve, 1″·189. 309°·17 (1830·47). Here we detect, at last, pretty certain evidence of motion in a double star, formerly considered stationary. By drawing up closer, while it gains the character of an unquestioned binary, it loses some value as a permanent test-object, for which purpose, however, it answers as yet admirably. My 5½-inch aperture divides it at present well with a power of 450, giving a dark interval equal to about 0·2 of either disc. Its gradual approach should be watched by all observers whose instruments can reach it, and measured by all whose apparatus can master it. It is not improbable that this ζ, and ζ *Cancri* already

described, may be following the example of a third ζ, that of *Hercules*, a wonderful pair, of very short, though not well ascertained period (Struve giving it but 14 years, Sm. 35); which having been measured by the latter at 1″·2 (1842·57), has of late years actually closed up to apparent unity. *ζ Boötis* is rendered additionally remarkable by Engelmann's confirmation of Struve's idea, that both stars are variable.

24. *a Herculis.* The stationary character of this fine object is confirmed.

25. *δ Herculis.* This also seems, notwithstanding previous conjectures, to be only optically connected.

26. *δ Serpentis.* 3″·313. 190°·73 (1864·42).—Demb., 3″·198. 192°·20 (1863·43). — Secchi, 3″·066. 195°·52 (1855·89). The suspected motion in this pair is now sufficiently evident.

27. *κ Herculis.* Stationary.

35. *ζ Coronæ.* 6″·195. 302°·8 (1864·48).—Secchi, 6″·213. 301°·71 (1856·49).—Struve, 6″.002. 300°·86 (1829·7). Hence Engelmann infers a slight, but pretty certain change of angle.

37. *σ Coronæ.* 3″·115. 190°·52 (1864·45).—Demb., 2″·759. 190°·06 (1863·09). The continued motion of this beautiful binary is evident, and it is to be hoped that we shall soon be in possession of data for computing a more satisfactory orbit.

38. *η Coronæ.* 1″·09. 28°·25 (1864·45).—Demb., 0″·81. 19°·04 (1863·03).—Secchi, 0″·535. 4°·5 (1859·48). The rapid movement of this most interesting pair is apparent, even from year to year, and its mutual divergence has brought it within the reach of even moderate instruments. Minute as the object is, how much it reveals to us of the wonderful mechanism of the universe! It is now an excellent comparative test in conjunction with the more difficult *ζ Boötis*. Recently (1865·46) I have found that 111 of my achromatic will strongly elongate it, and 450 show a division equal to 0·4, if not 0·5, of the disc of B. In such comparisons as these, however, it must be borne in mind that the quality of the eyepiece is somewhat involved, as well as that of the object-glass.

42. 70 *Ophiuchi.* 5″·425. 104°·77 (not good), (1864·48). Demb., 5″·666. 104°·96 (1863·06). The distance continues to diminish, the angle to increase.

43. *λ Ophiuchi.* 1″·777. 23°·4 (not good), (1864·45). —Demb., 1″·442. 19°·61 (1862·93). Motion very obvious.

47. $\epsilon^1$4 and $\epsilon^2$5 *Lyræ.*—ϵ^1, 3″·295. 19°·8 (1864·45).— Demb., 3″·045. 19°·35 (1863·09).—Secchi, 3″·07. 22°·42 (1856·24).—Struve, 3″·034. 26°·06 (1831·44). Angular

motion may be clearly recognized.—ϵ^2, 2″·455. 142°·7 (1864·45).—Demb., 2″·479. 143°·97 (1863·09).—Secchi, 2″·576. 148°·4 (1856·06). — Struve, 2″·573, 155°·17 (1831·44). Movement in both senses is still more evident here. The 9·5 mag. star keeps its relative position.

59. χ *Cygni.* Stationary; if the angle is not very slowly decreasing.

104. γ *Leonis.* 3″·387. 112°·93 (1864·31).—Demb., 2″·857. 109°·29 (1863·28). The results of different observers are still discordant, and the period must be very uncertain.

106. ξ *Ursæ Majoris.* 2″·568. 95°·42 (1864·2).—Demb., 2″·557. 96°·66 (1863·23). The distance appears to be again decreasing since Secchi's measure, 1857·357.

112. 72 P. II. *Cassiopeæ* (ι of Eng.). A and B, 2″·38. 267°·4 (1864·93).—Demb., 1″·927. 265°·87 (1862·99). Here Engelmann's measure (of a single night) is much less satisfactory than Dembowski's, reversing the diminution of the angle (as to which there is little doubt), and giving rather a *jump* to the distance.

Dr. Engelmann's mean values have always been cited. But it ought to be stated that, with the exception of *Castor* and ξ *Ursæ Maj.*, they are drawn from very few observations, and those not always very accordant; not unfrequently exhibiting only the result of a single night. And how liable such results are to further correction, all star-measurers know. Dembowski's have greatly the advantage in being deduced from a much larger number of observations. Still, every contribution is of value, and it is evident that truth will only be attainable through the means of a great amount of evidence, some of which must be expected to be of a conflicting character. Of this we have full proof in the recent observations at the Radcliffe Observatory, Oxford. It has been announced as the result of an examination, in 1863, of many of the stars in the Dorpat Catalogue, that they do not exhibit that degree of motion which Struve had concluded and anticipated. Deduced by means of a heliometer, the largest, or one of the largest in the world, and sustained by the *prestige* of a Greenwich reputation, the Oxford observations have a strong claim to be heard; and England loves fair play. But Struve has, and will have his supporters; and it is obvious that the matter ought to be fully gone into. That very considerable discrepancies exist is well known to all who search into the records of Double Star observations. But we have no right to wonder at the fact, when we consider that 1″ of arc is a very large value in these inquiries, and yet that quantity would be represented by about $\frac{1}{1000}$th of an inch in the focus

of an 18-feet telescope, or $\frac{1}{3000}$th in a 6-feet, so that, all the diversities and imperfections of instruments and of sight and of judgment considered, the real wonder is, not that there should be so much discrepancy, but that there should be so much agreement, in the results. It is obviously a question of testimony, and can only be decided by the patient accumulation and judicious selection of materials. All, therefore, who possess the means of measurement should endeavour to turn them to good account in the cause, and though the rough attempts of beginners can only give approximate results, yet we must remember that there was a time when Struve, and Smyth, and Dawes, and Secchi were beginners.

CRIMSON STAR.

Independently of its connection with our recent remarks on the colours of stars, the following striking object will be found worthy of a search from its intrinsic beauty. In p. 115 of our Vol. vi. mention has been made of Crimson Stars, but no especial instance was given. Such an one has, however, been obligingly pointed out to me by Mr. Knott, the first known recorder of its colour, in Oct., 1861, though not the discoverer of its existence, as it stands No. 1442 in the 18th hour of R.A. in Weisse's edition of Bessel's Zones. Observers whose instruments are provided with circles will hit upon it in R.A. 18h. 57m. 11s., D.S. 5° 53′; but it may be readily found without such assistance by means of its neighbour 12 *Aquilæ.* That star has been mentioned in p. 116 of our volume already cited, as the nearest of two a little *sp* λ *Antinoi,* the latter being a 3-mag. star, easily recognized from its position immediately *nf* the upper part of the hazy brightness of *Sobieski's Shield;* it is, in fact, the brightest for a considerable distance round it, and has only one competitor, δ *Aquilæ,* along the track of the Milky Way, between itself and *Al Tair.* Its next *sp* neighbour, 12 *Aquilæ,* 6-mag., having been identified, and placed in the centre of the field, we must sweep steadily on the parallel to the E. Having passed several small stars, barely exceeding 10-mag., which are plentiful in this region, we come to a star about 8-mag., having (if the field is a large one) on the N. an irregular line of three brighter stars lying nearly E. and W., and another brighter star *sf.* We then sweep on as far again in the same parallel to about 40′ of arc from 12 *Aquilæ,* when we come upon our object standing conspicuous among several very minute attendants. Its aspect is singular and striking, especially as contrasted with its whiter neighbours. The disk is of a rather feeble red, the intensity of light serving, perhaps, to make its

peculiar hue less evident—an effect which I have noticed in other deeply-coloured stars; but the surrounding rays are of a decided crimson cast. It is very much to be regretted that though it is rated by Knott as 7·3 mag., and consequently rather larger than the generality of such objects, it must be far below any full or satisfactory spectrum analysis. Perhaps some future time it may by reached with an aperture such as those of Lassell or Lord Rosse: and we may then expect some strange, though not improbably unintelligible, revelation as to its constitution. We cannot picture to ourselves the state of affairs consequent upon our being brought under the influence of a crimson sun; but we may conjecture that its effect upon a planetary system, if such surrounds it, must involve a very different constitution of things from anything within our solar bounds.

The star is readily visible, though of course not its hue, in a finder of little more than one-inch aperture. It seems remarkable that it should not be included in the list of Ruby Stars given by Sir John Herschel as an appendix to his Cape Observations, especially as the majority of his objects are of smaller magnitude.

REMARKS ON SATURN.

BY RICHARD A. PROCTOR.

Mr. Richard A. Proctor, of Stoke, Devon, author of *Saturn and its System,* reviewed in our last number, sends us the following:—

"Will you permit me to discuss, briefly, one or two remarks in your notice of my little work on Saturn? I wish to examine—first, the supposition that Saturn's rings may be vaporous; secondly, the opinion that the satellite theory is inadmissible in the case of the dark ring. Before doing so, however, let me observe, in answer to your remark that you 'would have been altogether better pleased with a fuller system of reference to original authorities,' that (excepting, of course, much that may be considered common property) I can conscientiously claim as my own every sentence, opinion, or calculation in *Saturn* which is not distinctly referred to an authority.

"The hypothesis that the rings are vaporous, may, I think, be very easily overthrown. Bessel calculated the weight of the rings to be $\frac{1}{118}$th part of Saturn's weight. The volume of

the rings (accepting Bond's estimate of their thickness) is less than $\frac{1}{350}$th part of Saturn's volume. Hence, the mean density of the system is more than double Saturn's mean density—or exceeds, by more than one-half, the mean density of water. Add to this the general permanence of the rings' form, and their power of intercepting and reflecting light (for the planet's shadow on the rings proves they are not self-luminous), and the idea that the rings are vaporous may safely be dismissed.

"The 'circumstance that the inner edge of the bright ring is' generally 'clearly distinguished from its darker neighbour,' is accounted for at p. 126 of *Saturn*. The objection drawn from the appearance of the dusky ring where it crosses the ball of the planet appears, at first sight, more formidable. It would, no doubt, require a powerful telescope to detect 'a thinly-scattered stream of light-reflecting satellites in front of the ball, supposing the latter uniformly illuminated. But we must not forget that each satellite, thus placed, casts upon Saturn a black shadow. Now, when the rings are open, the inner edge (even) of the dusky ring is more than 10,000 miles from the part of Saturn apparently behind that edge. Thus it may easily be shown, that if the line of sight from the observer to a satellite is inclined 10″ to the line from the sun to the satellite, the apparent place of the satellite on Saturn's disc would be removed half a mile from the shadow of the satellite. Hence, remembering that the satellites composing the ring must be very small, that the equatorial horizontal parallax of Saturn in opposition is 1″, that Saturn's disc in opposition subtends an angle of 19″, that when Saturn is in opposition lines from Saturn to the earth and sun may be inclined to each other in an angle as great as 2° 45′, while when Saturn is in other aspects the corresponding angle may be as great as 6° 23′, it is clear that nearly all the satellites are at all times shifted from coincidence with their respective shadows, and thus the black-spotted background of the disc is revealed. Hence, as the shadows (like the satellites) are not separately visible, the stripe of the disc crossed by the ring presents the observed appearance—dusky, but not nearly so dark as the other part of the ring, because the background is not black, but merely strewn with black spots.

"The fact is, that although, no doubt, 'it is extremely difficult to form any idea of the real nature of the rings from observation,' yet, in the present state of science, the system is far from 'offering a wide field for the admission of dissimilar theories.' The rings must be solid, fluid, or vaporous, and either continuous or discontinuous. I have shown that the idea that they are vaporous must be rejected, and absolutely insuperable dynamical reasons compel us to reject the idea that

they are solid or fluid continuous bodies, or composed of separate rings, however numerous, and whether solid or fluid. Hence it follows that the system is composed of separate bodies, necessarily small, since otherwise they would be separately visible.

"I may remark, in conclusion, that I am *very* far from claiming for my work the character of 'an exhaustive monograph;' but I think some of the observations referred to as not noticed in *Saturn* are referrible to disturbances of the earth's atmosphere, rather than to peculiarities in the physical condition of Saturn's system."

[We think that Mr. Proctor has quite misconceived our meaning with regard to "reference to original authorities." We have no idea whatever that he has not made the most perfectly warrantable use of his materials, or that he has in the least attempted, or wished to attempt, to take credit for anything not justly his own. But it is not so easy as it might have been, and as we should have preferred, for his own sake as well as his readers', to ascertain what his materials were. We always consider it matter of regret when writers of merit, in treating of subjects requiring accuracy, and involving possible differences of opinion, do not indicate explicitly the sources of their information; it is scarcely fair even to themselves, as exposing them in some cases to remarks which may possibly have no foundation, but for which, as arising from their own reticence or indistinctness, their readers are not to blame.

With regard to the idea of a possible vaporous constitution of the rings, which did not originate with us, and which we are not much concerned to defend, we may observe that Mr. Proctor's conclusion can have no greater force than his weaker premises, which assumes, what we are not disposed to admit, that the materials of the Saturnian system, and their modes of existence, are more similar to our own than has ever yet been demonstrated—we may perhaps add, are ever likely to be. We know absolutely nothing of the possible density of vapour there, the substances which may compose it, or the conditions under which it may subsist. As to the power of intercepting and reflecting light, it seems to us to present no obstacle. A mass of dense terrestrial cloud in the position of the ring would, we believe, be found fully as luminous, and its shadow equally obscure.—So again, in giving Mr. Proctor great credit for his solution of our difficulty as to the appearance of the dusky ring across the ball, we cannot say that it appears entirely satisfactory to us. The introduction of the shadows of the satellites is very ingenious; but though we admit that those shadows would seldom be hidden by the bodies that produced them, we think that, considering the multitude of

satellites required in order to make the ring visible at all, a large proportion of the shadow would still be always concealed from us by the interposition of satellites, though not of the individuals which caused them, and that the "black-spotted background" would be much less visible than observation shows, through the luminous stream. And even if, for argument's sake, we were to admit that every shadow contributed its visible share to the dusky appearance, we should only shift the difficulty; for the satellites ought to be at least as visible upon the sky, as their shadows upon the ball; which is entirely contradicted by experience. We will nevertheless suggest, in Mr. Proctor's favour, that possibly this objection might be somewhat mitigated by the supposition that these satellites may have a reflective power so inferior to that of the ball that they may be projected as dark spots upon it, as those of Jupiter frequently are when in transit. We have no wish, however, to prolong the discussion, but still believing, as we venture to do, that there is abundant room "for the admission of dissimilar theories," we wish nothing further than a free ventilation of the subject, and fair play for all. As to the probability that the details not noticed by Mr. Proctor may be referred to "disturbances in the earth's atmosphere," we hope that our readers at some future time will have an opportunity of forming their own opinion from a detail of the original observations.]

LITERARY NOTICES.

Sea Fishing as a Sport; being an account of the various kinds of Sea fish: how, when, and where to catch them in their various seasons and localities. By Lambton J. H. Young. (Groombridge and Sons.)—The numerous class of sea-side visitors who are fond of boating, and the possessors of yachts, will find this a very handy book. Mr. Young describes the various kinds of apparatus required for sea-fishing, and gives simple directions for their employment. Then follows a chapter on "baits," and a third on "fish," in which there is a compendious account of nearly every object which the fisherman is likely to seek. This part of the work is judiciously condensed, so that a marine sportsman can readily find the information specially necessary for his craft. The work closes with a brief history of sea fisheries. Mr. Young regrets the discontinuance of the collection of statistics of English fisheries since 1850, and recommends the employment of the coastguard and custom-house officers for that purpose. Few persons are aware of the immense importance of our fisheries, not only as a means of procuring food, but as supplying an excellent employment for our seaboard popu-

lation. In 1859, Mr. Young, quoting the returns, says—"12,802 boats, manned by 43,062 fishermen and boys, were employed in the herring, cod, and ling fisheries, and the total estimated value of the boats, nets, and lines employed in these fisheries was £739,096." Many important questions relating to the habits of fish can only be elucidated through the systematic collection of a great mass of information, and this is a kind of labour which the Government should undertake; but there is ample room for individual exertion, and if a larger portion of those who are addicted to maritime recreations could be inoculated with scientific tastes, much good might be achieved. At present we are totally ignorant of the causes of good and bad seasons for herrings and many other fish, and it is most desirable that efforts should be made to explain the reasons of their visiting or deserting particular localities. "Sea Fishing as a Sport" is a handsomely-printed volume—not too big for the pocket, with ample margins, and plenty of headings, so as to adapt it for quick reference. It is also furnished with eight well-executed plates of fishing-vessels, tackle, etc., not the least interesting of which are numerous diagrams of knots, in which the mystery of the ingenious fastenings in which sailors delight is clearly explained.

A History of British Ferns. By Edward Newman. The fourth, or school edition, with plates and glossary. (Van Voorst.) —We welcome a cheap edition of Mr. Newman's ferns, but we do not understand why it should be called a "school edition," as it is not likely that any number of schools will take up the fern family as a specialty in their course of instruction. Elementary instruction in systematic botany ought to form a recognized branch of ordinary education, and pupils fairly taught would then be prepared to pursue any particular branch of the study to which their interest might be excited. Mr. Newman's merits as a writer on ferns have always been acknowledged; but he is not entitled to treat all other writers as merely copyers of what he has done. His book is a valuable one, and the issue of a cheap edition will induce a great many admirers of ferns to become purchasers; but we think some other writers have arranged their descriptions in a manner more convenient for quick reference in practical use. Mr. Newman's mode of numbering the objects in his plates is exceedingly good. Every fern is described in order, with a number prefixed, and that number marks the position of the corresponding figure in the plates. His directions for the cultivation of various kinds of ferns will especially commend his volume to many families who delight in this elegant mode of decorating their abodes.

A Dictionary of Science, Literature, and Art: comprising the Definitions and Derivations of the Scientific Terms in general use; together with the History and Descriptions of the Scientific Principles of nearly every branch of Human Knowledge. Edited by W. F. Brande, D.C.L., F.R.S., L. and E. of Her Majesty's Mint; and the Rev. George W. Cox, M.A., Late Scholar of Trinity College, Oxford, assisted by gentlemen of eminent scientific and

literary acquirements. Part V. (Longmans.)—The good opinion we formed of this work (physiology excepted) is confirmed as it goes on. It will be a very valuable book for general reference. The present part (V.) begins with G, gets as far as I, as Iguanadon.

HOMES WITHOUT HANDS. By the Rev. J. G. WOOD, M.A., F.L.S. (Longmans.) Part XIX. contains the usual variety of interesting matter. The frontispiece exhibits the albatross with its nest. The other illustrations are excellent, and the letter-press ranges from the homes of various insects to those of mice. Part XX., which completes the work, commences with a striking landscape picture of the elk. Moths and birds, besides the elk, occupy its pages; and although throughout the work the arrangement is not technically scientific, it has assisted the author's purpose of providing varied and entertaining reading.

FOR AND AGAINST TOBACCO. By BENJAMIN WARD RICHARDSON, M.A., M.D., Senior Physician to the Royal Infirmary for Diseases of the Chest. (Churchill.)—Dr. Richardson embodies his researches into the action of tobacco on the human frame, in a stout pamphlet, containing a great deal of interesting matter, and yet not quite satisfactory, partly from the difficulties naturally pertaining to the subject, and partly from his not adequately discriminating the different effects of large and small doses of the fumes which smokers take into their mouths. Watery vapour, free carbon, ammonia, carbonic acid, and an oily product composed of nicotine, a volatile substance of an empyreumatic odour, and a bitter resinous extract, are the substances which he finds in tobacco smoke. The quantity of these materials taken into the system will depend upon the quality of the tobacco, and the mode of smoking it. One good Havannah cigar is found by Dr. Richardson to yield enough poisonous matter, when its smoke is condensed, to induce active convulsions in a rabbit, and six pipes of common shag tobacco yield sufficient poison to destroy a rabbit in three minutes. Before a smoker has got used to his occupation, the tobacco produces, as is well known, considerable discomfort and disturbance; and judging by comparison with what he has observed in lower animals, Dr. Richardson conceives the brain of the patient to be pale and empty of blood, his stomach to be reddened in round spots, his lungs to be as pale as those of a dead calf, his heart overburdened with blood and contracting feebly, "every fibre being impregnated with a substance which holds it in bondage, and will not let it go." After a few experiments, the unpleasant effects are moderated, and cease, the poisonous matter being eliminated by the skin, the lungs, and the kidneys. If the lungs are weak or obstructed, the smoker becomes saturated with the products of the weed, and not only his clothes, but his skin, diffuses odours that remind one of a concentrated extract of taproom, and which no nasal organ could commend. The volatile tobacco poisons escape by the skin and lungs, the nicotine and bitter extract enter the body in solution with the saliva, and are supposed to be discharged by the kidneys. "In the confirmed smoker there is undoubtedly a constant functional disturbance; *i. e.*, his organs are doing work which

is not essential to their duties; but they do it with moderate ease; they receive nothing that is deposited in their structure, and, let alone, they soon regain their natural condition. In the recognition of these simple truths, the whole gist of the tobacco controversy is enclosed; it is on the presence of the functional disturbance that the vehement anti-tobacconist bases his arguments; it is on the absence of organic mischief that the advocate of tobacco rests his defence." This is Dr. Richardson's philosophy of the whole matter; but while disposed to go a little way with the anti-tobacconists, we think it necessary to guard against supposing that every disturbance of function is necessarily a mischievous thing. This must, we imagine, depend on the amount of the disturbance, on its precise character, and on the state of co-ordination or the reverse in which the various functions previously existed. The red globules of the blood are found by Dr. Richardson to be much affected by smoking; "they lose their round shape, they become oval, and irregular at the edges, and instead of having a mutual attraction for each other, and running together—a good sign of their physical health—they lie loosely scattered before the eye, and indicate to the learned observer that the man from whom they were taken is physically depressed or deplorably deficient in muscular and mental power." Dr. Richardson tells us that these remarks result from direct observation of the blood of smokers in every phase of *poisoning* by tobacco, and he believes they fairly represent the action of tobacco on the blood. But is it right to assume that moderate smoking in persons that are seasoned to its influence really *poisons* them at all? Is it not more probable that the functional changes it effects are in many cases beneficial? Dr. Richardson explains how rapidly the poisonous effects may pass away; but if a hard-working man smokes his pipe, and feels refreshed by it, is it correct to suppose that his resumption of labour is an indication that he has recovered from a mild attack of poisoning? What proof is there that he has been poisoned at all? Tobacco is admitted by Dr. Richardson to have "the property of checking the oxydation of the body, and thus of diminishing waste;" and if so, there must be occasions for its use in appropriate quantities, to which no poisonous action could be ascribed. Many of the charges against tobacco are rejected by Dr. Richardson on what appears good grounds; but he thinks it prone to occasion a peculiar disorder, described by Dr. Gibb as the "smoker's sore throat," of which enlargement of the tonsils constitutes one symptom. In consumption and chronic bronchitis, Dr. Richardson finds smoking decidedly mischievous; and on the whole, he regards it as "a luxury which any nation of natural habits had better be without;" and he adds, "I do not hesitate to say that if a community of youths of both sexes, whose progenitors were finely formed and powerful, were to be trained to the early practise of smoking, and if marriage were to be confined to the smokers, an apparently new and physically inferior race of men and women would be bred up." With this we thoroughly concur, and think that any rational parent would desire to prevent boys from smoking, just as they would object to their beginning life with dram-drinking.

Bad as Dr. Richardson thinks of tobacco, he regards it as less hurtful than alcohol or opium, and no worse than *tea and sugar*. With this comfort, the smokers will feel able to enjoy their pipe, because, bearing due reference to the conditions of modern civilization, very few scientific men would venture to assert that the moderate use of all stimulants, or of sugar, is detrimental to health.

ARCHÆOLOGIA.

A very remarkable tumulus called Beller's Nap, in the parish of Charlton Abbots, in Gloucestershire, has recently been excavated by Mr. W. Lawrence, F.S.A. It is one of those tumuli commonly known as *long barrows*, being of great length and elevation, and it is situated upon high ground in a secluded district. Mr. Lawrence's careful researches show that it had been constructed over four distinct chambers, each formed of very large stones. These chambers contained human skeletons, but unaccompanied with urns, weapons, or other objects. The huge mound was composed of stones, in the removal of which, not effected without great labour, some few fragments of pottery were found, which appear to be Roman, or Romano-British, which means nearly the same thing. The discovery of these fragments has suggested to some that the mound had been, at some former period, opened and the chambers rifled, but it was the opinion of the excavators themselves, and they were probably correct, that this was not the case, and that the barrow had not previously been disturbed. Some of the skulls were sent to Cheltenham, to be examined, it was said, by a craniologist. One of the original entrances to the mound is very imposing, from the height and peculiar construction of the walls, which commence at a considerable distance within the mound, and extend on each side outwards, sweeping round and gradually diminishing until they are only about a foot apart. They are composed of laminæ of the peculiar slaty stone of the district, laid one over the other, and resembling, in many respects, the walls, or fences, of the fields, except that the former are built of smaller stones. Mr. Lawrence is, we understand, preparing plans and drawings for a detailed account of this discovery, which is to be laid before the Society of Antiquaries during their next session.

Excavations made by Mr. Farrar in Chedworth Wood, Gloucestershire, promise to lead to interesting discoveries. The foundations of a very extensive Roman villa are being brought to light; some of the rooms have tessellated pavements; and there is a suite of baths provided with water by a reservoir of stone supplied from a spring. This part of England appears to have been, in Roman times, remarkable for the number and splendour of its villas.

A very interesting Roman villa has also been excavated on an estate of Lord Eldon, about eight miles from Cirencester. It is

situated on the slope of a hill. Its extent may be imagined from the fact that upwards of thirty rooms have been already traced, three of which have good tessellated floors, and it has three baths. An Archæological Society has printed a paper on the subject of this villa, the writer of which suggests that it was the palace of the "king of Britain," Arviragus, who, perhaps, never lived anywhere but in the fabulous history compiled by Geoffrey of Monmouth.

The age of the introduction of PAPER into Western Europe in the Middle Ages has recently been a subject of considerable discussion, but unfortunately among scholars not very profoundly acquainted with the subject. Paper was, of course, common in England throughout the fifteenth century, and it was in use, though it was then much rarer, in the latter half of the fourteenth. We then find books made of leaves of paper intermixed with leaves of vellum, which, perhaps, shows that there was not much difference in value between the two articles. The last portion of the Surrenden library, collected by the Kentish family of the Derings, and recently brought to the hammer, contained what is described as "evidence of five marks of rent to Cobham College," forming a small roll of paper, and said to have been written in the reign of Richard II.; and also an *inquisitio post mortem* on the death of John de Northwode, with an extent of the manor of Thurnham on paper, to which the date of 1319 is given. We are inclined to suspect that there is some error about the latter at least. Paper was, no doubt, brought into England from France, where it was in use at a rather earlier date. We remember a few years ago examining a few curious little documents in Paris; they were shown to us in the then Royal, now Imperial, Library, we believe by Champollion Figeac, and consisted of bonds for money lent to Crusaders, at the time of the Crusades under Richard Cœur de Lion, and the French St. Louis, and several of them were written on pieces of paper. We are not quite sure that any of the paper documents belonged to the time of King Richard, though we think that was the case; but they were certainly not more recent than the date of St. Louis's crusade. The paper appeared to be of Italian manufacture.

The researches of the geologists and naturalists in search of evidence of the antiquity of man, have given rise to many strange stories, and have unfortunately given a new impulse to the manufacture of *false antiquities*. Forged flint implements are now scattered about by bushels, and it is very difficult to avoid being deceived by them. Among the strange stories which have recently appeared is a statement published in one of the local French papers, to the effect that, in one alluvial deposit between Veyziat and Oyonnax, in the department of the Ain, a fossil man, four *mètres*, that is, rather more than thirteen feet in height, in a horizontal position, but "with his head downwards and his feet in the air." How so gigantic an individual came into such a singular position, appears not to admit of easy explanation, but the account is said to be authenticated by some apparently very respectable names.

The excavations at SILCHESTER continue to be carried on under

the direction of the Rev. Mr. Joyce, the incumbent, and at the expense of the Duke of Wellington, the lord of the land. Unfortunately, the covering of earth over the Roman level is here very shallow, in which case, as we might expect, the objects scattered about are less numerous than when the covering is deep, because the old floors, etc., have been longer bared to the view, and, therefore, exposed to depredation. Many Roman coins, implements in iron, and other such things, have, we understand, been gathered by the excavators, and the foundations, as far as yet uncovered, present many features of great interest. The Roman town appears to have been crossed by streets regularly laid out, as at Wroxeter; one tessellated pavement has been found in a tolerable state of preservation; and there can be no doubt that, as the excavations proceed, they will throw more and more light on the condition of Britain under the Romans. T. W.

PROGRESS OF INVENTION.

Non-Explosive Gunpowder.—It has long been known that filling up the interstices between the grains of gunpowder, prevents or retards its explosion—room being no longer left for the expansion of the gases which are evolved, as the grains ignite one after another in rapid succession. It is not necessary that the substance used to produce this effect should be non-combustible, since even gunpowder itself, in a state of minute subdivision, greatly retards the explosion of that which is granulated. Some materials would be inadmissible as preservatives against the accidental explosion of gunpowder, because they absorb moisture, others because they would injure the glazing. Sand is liable to both these objections; and most probably glass, since it must scratch the grains, and in the course of time it becomes alkaline, consequently hygrometric. It is indispensable that any substance mixed with gunpowder to protect it should be easily and thoroughly removable, though not spontaneously. Now it is doubtful if any mixture of the kind would remain complete during carriage; and it may be proved, by using a white powder, that a sieve would not effect a perfect separation—while, unless the protecting powder is completely removed from the gunpowder previous to use, its goodness would be seriously impaired. Mr. Gale, a chemist, of Plymouth, has recently made experiments on this subject, which have attracted considerable attention; chiefly, perhaps, because it was not generally known that gunpowder has long since been rendered inexplosive by means identical with those used by him, but which have not been adopted in practice, on account of the objections to which they are liable. M. Piobert, of St. Petersburg, made experiments with inexplosive powder in 1835, and M. Fadeieff between 1840 and 1844. M. Piobert, among the various substances which he tried, found that each of the constituents of gunpowder itself would answer well;

but he preferred a mixture of charcoal and graphite, as not in the least hygrometric. Mr. Gale uses powdered glass. When an equal quantity of this is mixed with gunpowder, the explosion resembles that of a squib, and the effect is nearly the same when one part gunpowder and two parts glass are used. Three parts glass entirely prevent explosion; and, with four parts, even a red-hot poker produces no effect. When unprotected gunpowder is exploded in the midst of that which is protected, the latter is merely scattered. M. Piobert used only enough of the foreign substance to prevent the gunpowder from being dangerous. The objections against any protective medium are serious; the comparative cheapness of carriage with non-explosive powder would, no doubt, compensate for its greater quantity; but the processes of mixing and sifting would be dangerous, and in many cases objectionable; unprotected might be fatally mistaken for protected powder, and the very process of mixture would most probably cause a deterioration which could not be permitted. The project, on the whole, appears to be one of those which are extremely plausible only until carefully examined.

Nitro-Glycerine.—This highly explosive compound has been lately applied, by M. Nabel, a Swedish engineer, with great success, in mining. It was discovered in 1847 by M. Sobrero; but until now was not applied to any useful purpose. It is far less costly than gunpowder, though four times stronger. It requires no tamping, and may be used where, on account of the dissipation of the gases produced by the explosion of gunpowder, the latter would be ineffective. When the hole formed in the rock is sufficiently deep, any fissures which may have been discovered in connection with it are to be stopped with clay, to prevent the escape of the nitro-glycerine. The latter may then be poured in, and after it water, which will float on its surface: a slow-match, having a percussion-cap at the end, is next introduced into it. During some experiments that were made in blasting a dolomitic rock, a litre and a half of the nitro-glycerine, placed in a hole seven feet deep, and ten from the outer face of the rock, produced two great fissures, one fifty and the other twenty feet long; and three-quarters of a litre, in another case, poured into a similar hole, threw down about one hundred cubic metres of the rock. With nitro-glycerine, the expense is only one-half as much as with gunpowder, to produce an equal effect.

Electricity the Cause of Animal Colours.—M. Nicolas Wagner has recently brought before the Academy of Sciences experiments which seem to show that electric currents are the cause of the colours, at least of some animals. These experiments were made on the nymph of a species of diurnal butterfly (*Vanessa urtica*). Electric currents changed the reds into orange, and the blacks into red; and the most feeble current, especially if from a constant battery, produced black spots, the shape of which had a relation to the current. He ascertained, by means of an extremely sensitive apparatus, that not only does electricity modify and even produce colours, but that those found in the butterfly are

due to currents in the wing of the animal—the most energetic of which issues from the base of the wing, and follows the middle nervure till it reaches the outer edge.

VENTILATION OF SEWERS.—M. Robinet, a French chemist, proposes to ventilate sewers by causing the air required for combustion in factories to be obtained from them. According as the impure air is taken away by the draught of the furnaces, pure air will rush in from the atmosphere. He calculates that the Parisian sewers would be emptied of their contents many times a day, even though only some of the furnaces in that city were thus supplied with air. The sewers are a source of great danger in this country, also, from the noxious effluvia they emit, and which but too often find their way even into dwellings. There is no reason why a means of ventilating them so simple and effective should not be adopted.

ETCHING IN RELIEF.—M. Boettger has lately invented a simple process for this purpose. The drawing is made with a quill on clean polished zinc, with a solution containing one part dry chloride of platinum, and one part finely powdered gum arabic, in twelve parts, by weight, of water. Before the writing is quite dry, the plate is immersed for a few moments in a solution of aurocyanide of potassium, which covers it over with a thin coating of gold. It is then placed in a liquid containing one part nitric acid, spec. grav. 1·2, and sixteen parts water, and rubbed with a camel's-hair brush. The gold peels off, except in the places covered by the lines of the drawing; and, after some time, the hollows will have become sufficiently deep for the plate to be used in printing.

DANGER FROM CONTACT WITH A PERSON STRUCK BY LIGHTNING.—It might be supposed that, when any one is struck by lightning, the electric fluid immediately passes away, on account of the conducting power of the animal body, and of the objects in contact with it, especially if moisture is present. This, however, does not always occur; though our present knowledge of the laws of electricity will not suffice to explain the exceptional cases. Two instances illustrating this subject have been brought before the Academy of Sciences by M. Boudin. One occurred on the 30th June, 1854. A man was killed in the *Jardin des Plantes* at Paris, by lightning, and his body was exposed for some time to heavy rain. When, however, two soldiers attempted to remove it, they received, the instant they touched it, a very violent shock. The other happened on the 8th September, 1858. Two artillery men, at Zara in Dalmatia, were appointed to remove telegraph posts; on attempting to lay hold of them after a violent thunder-storm, they were thrown down and greatly injured, especially one of them. When a comrade endeavoured to assist him that was most hurt to rise, both were dashed violently to the ground; the comrade was burned in the arm, and was afterwards affected with nervous symptoms.

THE SENSITIZING OF IODIDE OF SILVER.—The different deportment of iodide, under the action of light, from that of other salts of

silver, has long attracted the notice of chemists and photographers; but the reason of this difference, though involving very important considerations, has not been hitherto understood. Even unexplained facts are valuable, but an explanation very often renders them infinitely more so. Such is the case with regard to the peculiarity of iodide of silver. Dr. Vogel, of Berlin, has recently thrown a new light on the conditions which render this salt sensitive, or the contrary. It was long known to photographers that iodide of silver, formed with excess of iodide of potassium, is totally insensitive to light; but that, when the nitrate has been left in excess, it is highly sensitive. In looking for the reason of these facts, it occurred to him that certain compounds are decomposed immediately by heat, while others, in addition, require the presence of a body that has an affinity for an element which the heat will set free. Thus, heat by itself will decompose oxide of silver, but it will not decompose oxide of iron, unless hydrogen is present to unite with the liberated oxygen. The consideration of this difference in the powers of heat led him to suspect that the action of light might be analogous; that, by itself, it might decompose some compounds, while it would have no effect upon others, except in presence of a body which could unite with an element it should disengage; and further inquiry showed that he was right. Here then was found an explanation of the apparent anomalies connected with the salts of silver. The chloride, for instance, is decomposed by light alone; the iodide requires the presence of some substance that will combine with the liberated iodine: such a substance is found in nitrate of silver, and in tannin, bodies which, at first sight, would seem to have nothing in common. The principle once discovered, it was found to be susceptible of very extensive application; any substance ready to combine with the liberated iodine will answer instead of the nitrate of silver, or the tannin. It is chiefly the excess of nitrate, present in wet plates, that renders them more sensitive than those which are dry; but such a substitute for nitrate of silver may be found as will impart an equal sensitiveness to dry plates—one of the greatest boons that could be conferred on the photographer.

Enamelled Silver.—The art of enamelling is very ancient; its products are both very beautiful and very durable. Its utility has, however, been circumscribed by various circumstances, among which is to be reckoned a restriction as to the material on which the enamel is produced. This has usually been copper or gold: the former is objectionable for several reasons, the latter from its dearness. Silver would be a very appropriate material; but, until recently, it was not possible to use it in enamelling. M. Auguste Geffroy, of Paris, has, however, after a long series of experiments, discovered the means of employing it for the purpose, and intends very shortly to make known the causes which have led to the failure of others, and to his own success.

Improvement of the Air-pump. — Certain imperfections are observable in the ordinary air-pump which, hitherto, it has been

found impossible to get rid of. Among these is a great friction between the piston and the barrel, and, worse still, the disarrangement of the valves, on account of the oil used for lubrication getting into them. M. Deleuil believes that he has avoided these, in a new form of pump, which will answer at least for those industrial purposes in which only a moderate vacuum is required. Strictly speaking, it is but a modification of the hydraulic pump, to which we have already directed the attention of our readers.* The piston, which so nearly fills the barrel that only a sheet of paper can be inserted between them, is of a length equal to twice its diameter, and has grooves on its surface distant from each other about four-tenths of an inch. When this piston is moved backwards and forwards in the barrel, even with moderate rapidity, a vacuum equal to from three to seven inches of mercury is produced in a comparatively short space of time. As the air drawn from one direction may be forced onwards in the opposite, the apparatus may be used as a condensing pump, so as to produce a pressure of about two atmospheres.

New and Simple Mode of Reproducing Drawings, etc.—The drawing having been made with a solution of gum, glue, varnish, or any other fluid which will impart hardness, it is transferred to a plate of plaster of Paris, chalk, or anything else that is easily pulverized. This plate, having been allowed to dry, is brushed until the material between the lines of the drawing—which is not affected by the process—is removed to a sufficient depth: after which it is immersed in gum, or glue, to harden the entire surface. The result is an admirable copy of the drawing in relief, and from this a *fac simile* in metal may be obtained in the usual way.

Miscellaneous.—*Photography in the Dark.*—If a sheet of paper, prepared with a solution containing 400 grains of isinglass, 440 grains of iodide of potassium, 146 grains of bromide of potassium, 54 grains of chloride of sodium, and 40 ounces of water, though it is not sensitive to light, is placed upon a picture, and another sheet beneath it, and they are left in contact for some time in the dark, the upper sheet will be found to contain a negative of the picture, and the lower a positive, in which the light greens and blues will be represented by white, and the reds by red. It has not yet been found possible to fix these.——*Roofs on the principle of Suspension Bridges.*—M. Lehaître, a French civil engineer, proposes to construct roofs having a span very far greater than any hitherto attempted, by supporting them with suspension cables. They will have an advantage over suspension bridges, in being free from the injurious effects produced by varying loads.——*Origin of Diamonds.*—It has recently been shown by Professor G. Oppert, with great probability, that diamonds are the result of the decomposition of vegetable matter. They often contain, on their surface, impressions of grains of sand, etc., and within them, fungi, and other organic bodies. This could not be the case if they were formed at a high

* Intellectual Observer, No. xxxvii. p. 78.

temperature—under which, indeed, they become black.——*Gun Cotton as a source of Motive Power.*—M. Jules Gros has invented an engine, in which motive power is derived from the gases evolved in one reservoir by the explosion of gun cotton, and condensed in another.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*June* 21.

Mammalian Remains found near Richmond, Yorkshire.—Mr. Boyd Dawkins described some mammalian remains, discovered last autumn on a terrace of blue clay, mixed with limestone débris, about 130 feet above the north bank of the river Swale, during excavations for a new sewer. The deposit appears to be a heap of kitchen refuse, the great majority of the bones being broken, while not one of the numerous skulls is perfect. The collection contained bones of the following species:—Bear, dog, pig, horse, red-deer, fallow-deer, sheep, *Bos longifrons*, *Bos brachyceros*, *Capra ægagrus*, and the horn-cores of a form of goat, which appeared to be the *Ægoceros Caucasica*, which had also been found by Mr. Dawkins and Mr. Sanford in a bone-cavern explored by them in 1863. M. Lartêt has expressed his opinion that these horn-cores belonged to some of the diversified forms that are the result of hybridity, and stated that they resembled some found in a bone-cave in the Pyrenees, which appeared to belong to a hybrid between the goat and the Bouquetin.

ZOOLOGICAL SOCIETY.—*June* 27.

Pigmy Fossil Elephants of Malta.—Mr. Busk communicated an account of his examination of the collection of fossil elephant bones made in Malta by Captain Spratt, R.N. These bones include the remains of three perfectly distinct species. One was nearly equal in bulk to the existing Asiatic species, and was probably referable to *Elephas Antiquus*. The others were remarkable for their diminutive stature as compared with the existing species of elephant. Neither of them exceeding the height of five feet when full grown. It might be imagined that the remains were those of young animals, but an attentive examination proved that their ossification had been perfectly completed, and that they consequently belonged to full-grown and perfectly mature individuals. Both these small species are distinguished by very well marked differences in their dental and osteological characters. The existence of a race of pigmy elephants in a European island is a circumstance of considerable interest, geologically as well as zoologically considered.

In connection with these elephantine remains from Malta, the arrival of a living specimen of the African elephant at the gardens of the Society in the Regent's Park may be noticed. The African elephant is perfectly distinct from its Asiatic congener, the structure of the molar teeth in particular being extremely different. The animals when living are readily distinguished by the immense size of the external ears in the African variety, these organs meeting on the upper part of the skull, and covering the entire scapular region and anterior part of the body. As both the Indian and African species now exist in the gardens, a very favourable opportunity is afforded of contrasting the striking differences between the two animals. Amongst the most strongly-marked distinctions is the difference in the formation of the prehensile organ at the end of the trunk in the two species. In the Asiatic this organ is usually compared to a flexible finger acting against the septum between the two orifices at the end of the trunk. In the African animal the end of the trunk appears divided horizontally, so that the upper and lower parts are of nearly equal size and power, and act against each other, opening and closing somewhat like a pair of pincers.

NOTES AND MEMORANDA.

THE HUMMING-BIRD HAWK-MOTH—*Macroglossa Stellatarum.*—Mr. C. S. Beckett, of Lyncombe Vale, Bath, writes:—Every year I have noticed an occasional visit from this attractive insect, and its peculiar habits have always excited fresh attention; but this summer, probably from the unusual warmth, has been marked by the arrival of numbers. My attention was first drawn to them one evening early in July, as I was contemplating a mass of jessamine in full bloom covering a rustic archway in our garden. It was twilight, and I felt much surprised at a whirring sound amidst the blossoms, and a busy scene, caused by no less than eight dusky-looking moths darting in and out of the branches. Their actions reminded me of my old favourite, but it was too dark to ascertain. Very near this starry mass a fly-catcher had taken up his station on a wall, whence he perpetually took airy excursions to capture invisible prey. I wondered he did not make a hunting-ground of the jessamine-bush; but probably he knew the moths were too sharp for him. The next morning I went to gather a large bouquet of jessamine, and to my satisfaction found four moths, no longer looking dusky, save the upper wings, but rendered rather attractive by the bright rust-coloured hinder wings, and bodies curiously tufted with white and black scaly hairs. They seemed little disturbed by me, and one even visited my bouquet, and most unceremoniously rifled the sweets of one flower after another as I held them in my hand, thus giving me an opportunity of closely observing its manœuvres, the vigilance of its hawk-like eyes, the accuracy with which it inserts its long, flexible proboscis into each flower, and its mouse-like head and body. Another day I watched it unerringly dip its needle tongue into the base of each petal of a carnation. It appears that the great length of this tube suggested the generic name: the specific name has nothing to do with this stage of its existence, but is derived from the stellate plants on which the caterpillar feeds, such as the Galiums. The caterpillar is inconspicuous, and probably not often noticed; but the perfect insect is so unlike the race of unobtrusive moths, that it well deserves attention, and many a quarter of an hour may be profitably employed and beguiled in watching the eccentric darting flight and habits of this lively little creature.

HEAT FROM ROTATION OF A DISC IN VACUO.—Mr. Balfour Stewart and Mr. P. G. Tait have been for some time engaged in very curious and important experiments on the heat acquired by the rotation of a disc of metal in vacuo. *The Proceedings of the Royal Society*, No. 76, contains a paper on this subject, from which it appears that a disc of aluminium, thirteen inches in diameter, was caused to revolve rapidly in a vacuum chamber. After moving for about forty seconds, at the rate of 2500 per second, a heating effect equal to 1° F. was indicated by a thermo-electric pile. The writers detail various reasons for believing that the augmentation of heat did not arise from the friction of the bearings, nor to "revolution under the earth's magnetic force," and they say that they are reduced to two possible causes—the friction of the air, which cannot be entirely got rid of in any artificial vacuum, or "the possibility that simple motion becomes dissipated by an etherial medium in the same manner, and possibly to nearly the same extent, as molecular motion, or that motion which constitutes heat," or the effect may be partly due to air and ether. It could not be due to air, because, in the first place, it was found not to be proportioned to the quantity of air left in the vacuum. Professor Maxwell and Mr. Graham considered that the fluid friction of air was not dependent upon its tension, and therefore diminishing the quantity of air in the vacuum would not proportionally diminish the friction action. Hydrogen fluid friction is much less than that of atmospheric air, but when a hydrogen vacuum was employed, the heating effect was so nearly the same as in an air vacuum, as to offer a second reason for not ascribing the heating to this kind of action.

NEW MODE OF SALTING MEAT.—M. Pienkowski informs the Academy of Sciences (Paris), that acetate of soda leaves meat in a condition in which it may be easily dried, has a pleasant smell, and can be unsalted easier than when prepared with chloride of sodium.

LIVING BODIES AND LIGHTNING.—In our last number we mentioned the case of a flock of sheep and their shepherd being struck by lightning on the Ourthe. M. A. De la Rive, commenting on this incident in the *Archives des Sciences*, observes that an agglomeration of men or animals in the open air augments the danger of their being struck by lightning, either by accumulating a greater mass of conducting matter on one spot, or by giving rise to an ascending column of vapour down which the lightning descends. Sheep, he says, herd very close together when they are frightened, and would thus produce this effect in a striking degree. He recommends persons caught in a storm not to stand too near each other.

ALLEGED REMEDY FOR CONSUMPTION.—Dr. Schnepp of Eaux-Bonnes states in the *Presse Scientifique* that an excellent effect is produced in consumptive patients by a fluid he calls *galazyme*, which bears some resemblance to the *kumis* of the Tartars, to which they ascribe valuable qualities. He takes two parts of asses' milk and one of cows' milk, and allows them to ferment. The fluid thus obtained should be clear and sparkling. He gives one or two glasses a day for a commencing dose, and raises the quantity to one or more bottles.

THE COLOUR OF MARS.—*Monthly Notices* contains a paper on Mars by the Rev. W. R. Dawes. He concludes that the ruddy tint of this planet does not arise from any peculiarity of the colour of its atmosphere, as the redness is most apparent in the centre where the atmosphere is thinnest.

MOBILITY OF THE SUN'S PHOTOSPHERE.—Mr. Brodie observed on 10th May, 1864, a large oval spot in the sun, and fringed all round with beautiful filaments of luminous matter stretching over and towards the centre of the umbra. In the course of three and a half or four hours, an unusually wide bridge of luminous matter had formed completely across the spot; . . . the bridge of luminous matter was about 3500 miles wide, and being formed across the oval-shaped umbra, at some little distance from its minor axis, the length might possibly not have been more than 5500 miles at that point. This would give the enormous velocity of 1400 miles per hour to the luminous matter which formed this bridge."—*Monthly Notices.*

Light Organs of Glowworms.—Professor Max. Schultze states that in males of the species *Lampyris splendidula* numerous trachæal branches in the luminous organs terminate in star-shaped cells. Osmic acid rapidly tinges these cells black, while the cells of the parenchyma remain colourless. It is, therefore, evident that the cells of the trachæa have the property of rapidly abstracting oxygen from the osmic acid, which readily parts with it.—*Archives des Sciences.* It will be interesting for our readers to try similar experiments with our English glowworm.

Absorption Bands and Temperature.—M. Feussner finds that chlorides of iron and copper, sulphate of copper, ammoniacal sulphate of copper, bichromate of potash, sesqui nitrate of nickel, proto-chloride of cobalt, and bichloride of platina, have their absorbing powers increased by heat. Chloride of copper in a suitable degree of concentration is completely opaque at its boiling point, and that portion of the spectrum which remains longest visible when the temperature is increased does not coincide exactly with that which is the last to disappear when the thickness of the layer is gradually increased. Chloride of cobalt at ordinary temperatures, and at a convenient degree of concentration, furnishes in the spectroscope two luminous bands, one of which, embracing all the red, all the yellow, and part of the green, is very intense, and the other of little brightness is situated in the violet. If heat is applied, the violet band diminishes in intensity, and two new bands, of which no trace previously existed, appear in the red. These bands increase rapidly in breadth, especially that which is the most refrangible, as the temperature augments, and when the boiling point is reached, they completely obscure the luminous band in which they are formed with the exception of a narrow and feeble ray at the extremity of the red.—*Archives des Sciences.*

Transparency of the Sea.—Father Secchi communicates to the French Academy the result of experiments made by M. Cialdi, commander of the "Immaculate Conception" corvette, from six to twelve nautical miles off Civitta Vecchia, where the sea depths varied from 90 to 300 metres. A great disk $3^{m}.73$, or rather more than 4 yards in diameter, formed of an iron hoop covered with cloth, painted white, and provided with apparatus for keeping it horizontal, was sunk on a remarkably clear day, and ceased to be visible at a depth of 42½ mètres, or about 140 feet. The sun's height was 60° 17′. Had the sun been vertical, Father Secchi says the disk might have been visible six or eight feet deeper. Smaller disks lost form so much by refraction that they could not be seen at the depths at which the great one remained visible. As the large disk was sunk to different depths its colour became first slightly green, then light blue, after which the blue grew deeper, until it could not be distinguished from the colour of the surrounding water. Thus the disk did not disappear because the light emanating from it was not permitted to reach the eye, but because after the sunlight had penetrated to a certain depth in the clear sea, and came back again through the water, it had lost all rays capable of characterizing the disk, and the light reflected from the disk could not be distinguished from that coming from the water around it. Very large objects, such as portions of the sea bottom, Father Secchi thinks might possibly be seen at 50 or 60 mètres deep in a sea like the Mediterranean, but he thinks there must be a mistake in the stories of the sea bed having been recognized at depths of from 100 to 200 mètres.

Electric Properties of Mineral Waters.—*Comptes Rendus* contains a note by M. Scoutetten on the electric condition of mineral waters. He states that such waters fresh from their source are in a state of chemical activity which gives rise to an active electrical current, recognizable by a galvanometer. He ascribes their curative properties to this exhibition of electricity. We would suggest that, if the electric state be as he describes, it does not follow that the curative action of the mineral water is directly dependent upon it. Very small quantities of chemical substances in a nascent state may, from the great facility with which they enter into new combinations, produce remarkable physiological effects, and electricity may have nothing to do with the matter excepting so far as is connected with chemical affinity.

THE INTELLECTUAL OBSERVER.

OCTOBER, 1865.

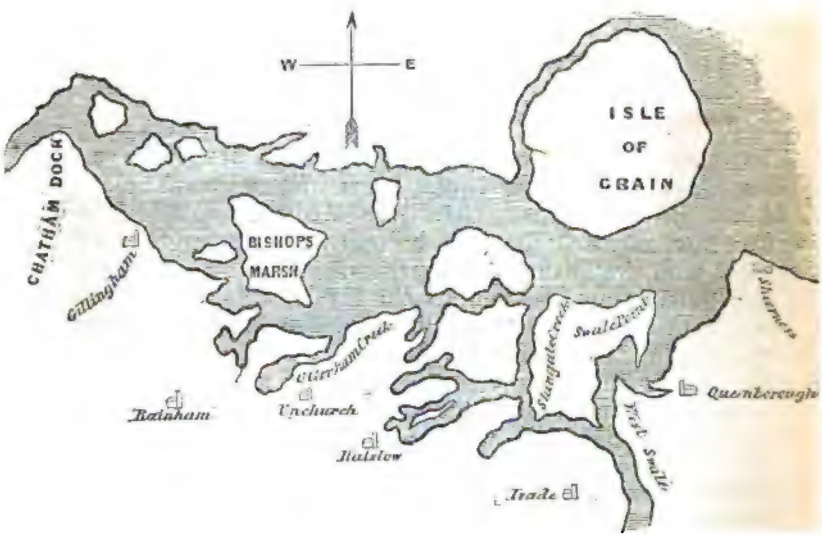
ROMAN POTTERY—THE UPCHURCH WARE.

BY THOMAS WRIGHT, F.S.A.

(*With a Coloured Plate.*)

The class of Roman pottery I now proceed to describe involves a rather curious geological question, as well as an archæological fact. Below Chatham, the River Medway expands into a succession of reaches, which become wider and wider until it unites with the Thames at Sheerness. From Rainham, about three miles below Chatham, to the Swale, which separates the main land from the Isle of Sheppey, the land on the south side of the Medway, which here runs nearly from west to east, is low and marshy for some distance from the shore. This low ground is cut, by the encroachments of the river, into numerous creeks, which will be best understood by a glance at the map given in our cut. The bottom of these creeks is formed of a soft, but very tenacious, clay, which may probably be two or three feet deep, and this is covered by an accumulation of from two to three feet of soil. In the clay we find at a slight depth a continuous deposit of Roman pottery, almost all either broken or defective, mixed with the remains of burnt fuel from the kilns, and attended with other circumstances, which leaves no room for doubt of their being the refuse of extensive Roman potteries. We may judge, indeed, of their extent from the fact that they reach along the river from Rainham to the Swale, between five and six miles, and inward, on an average, from a mile to a mile and a-half. The greater portion of this low ground is divided into the Upchurch Marshes and the Halstow Marshes, named from the two parishes over which they extend. This bed of pottery is nowhere seen to more advantage than in Otterham Creek, in the former parish, which winds up to near Upchurch church. To

explore this creek with any success, you must enter it with a boat at low water, when a large extent of clay is left uncovered on each side the water, which you can only walk upon, or rather into, with long waterman's boots, and you soon reach the layer of pottery underneath by means of a stick, or, which is the more effective method, by thrusting your hand and arm into the clay, when you may pull up almost as much pottery as you like. As the pottery was first observed and examined here, it has been called by antiquaries Upchurch Ware, though the Roman potters' works extended over several parishes. The pottery is no less abundant in the creeks and dykes of the Halstow marshes, from Otterham Quay to Stangate Creek, but



Map of the Upchurch and Marshes.

these localities are of less easy access than Otterham Creek. There can be no doubt, not only from the extent of ground covered by the potteries, but from the frequent occurrence of the sort of pottery made here, among Roman remains in Britain belonging to different periods, that these potteries were in full activity during the whole extent of the Roman period. The site of the kilns was moved as the clay was used up, and at the same time the refuse pottery was thrown on the ground behind them, so that, when at last abandoned, this extensive site presented a surface of ground covered almost entirely by a bed of refuse pottery. It would seem that, to produce its present appearance, the ground must have sunk, so

as to be covered with water, which perhaps deposited a new bed of clay, and that after this it must have become raised again, to receive its surface of soil, since which the water of the river has trespassed upon the ground in its new elevation, and formed the creeks as they now appear; and, though possibly the state of the ground may be explained otherwise, yet it is well worthy of consideration in connection with the interesting question of the change of the coast level.

The existence of these Roman potteries is not altogether a modern discovery. Dr. Battely, whose *Antiquitatis Rutupinæ*, or Antiquities of Richborough, was written before the beginning of the last century, had observed the remains of this

7 6 5 4 1 3 2 8 9

Examples of Roman Pottery from Upchurch.

pottery at Upchurch, which he terms *urnas atque vasa nigricantes*, "blackish-coloured urns and vases," and he speaks of it in that book, giving it as his opinion (in which he was correct) that the locality in which they were found was not a Roman cemetery, but the site of Roman potteries. The antiquaries of the last century, and of the earlier part of the present, neglected or despised the information given by Battely; and Halsted, the well-known historian of Kent, actually discredited the notion that such pottery had ever been found there. We owe our first knowledge of the full truth to our distinguished antiquary, Mr. Roach Smith, who has given interesting accounts from his own personal observation in the *Journal of the British Archæological Association*, and in his *Collectanea Antiqua*,*

* See the *Journal of the British Archæological Association*, vol. ii., p. 134, July, 1846; and Roach Smith's *Collectanea Antiqua*, vol. vi., p. 173, 1864. Mr. Roach Smith had first called attention to this pottery in 1840, in a communication to the Society of Antiquaries, printed in the *Archæologia*, vol. xxix., p. 223.

from which I take much of the information contained in the present article.

The Roman ware made in the Upchurch potteries presents distinctive peculiarities which cannot be mistaken, and it must have been in great repute, certainly the next after the foreign Samian and the native Durobrivian wares, in this province of the empire. Like the Durobrivian, too, it has been found, I believe, on Roman sites in France and Germany, so that it was probably exported. As Battely has described it, the greater proportion of this ware is of a "blackish colour," or rather of a bluish or greyish black, which was produced, no doubt, by the process of the smother-kiln, already described in our paper on the Durobrivian pottery. Some of the Upchurch pottery presents a colour approaching to dark drab. Examples of both are given in our plate. The forms, as well as the sizes, vary greatly, but they all present those delicate forms of the curve which we recognize at once as coming from the hands of the Roman artist. The texture of the pottery itself is fine, and it is very thin. The ornamentation also is varied, but not very elaborate, or very refined. One of the most elegant patterns is represented in the first figure in our plate. It consists of a band of half-circles, made with compasses, from each of which a band of parallel lines descends vertically. Another example of this class of ornament is given in one of the groups (2) in our accompanying woodcut. A pattern different from this, but still presenting some of the same characteristics; is shown in the lower figure to the left on our plate. This, again, both in form and in the character of its ornament, though it is more simple, may be compared with No. 4 in the cut. The little vessel (3) in the front of the cut has had two handles, but one is lost: it is supposed to be an incense pot.

The instruments used in the ornamentation of this pottery appear to have been of a very rude description, and were, as it seems, chiefly mere sticks, some sharpened to a point, and others with a transverse section cut into notches. The former were used in tracing the lines already described; the latter had the section formed into a square, or rhomboid, the surface of which was cut into parallel lines crossing each other, so as to form a dotted figure, and this was stamped on the surface of the pottery in various combinations and arrangements. An example of this description of ornament is given in the upper vessel to the right in our plate. Sometimes these dots are arranged so as to form bands, as in the example in the back of the group in the woodcut (5). The middle figure in our plate represents another ornament, which is more difficult to describe, but which is not uncommon. The large urn in the middle of our group in the woodcut (1) furnishes an example

of another kind of ornamentation found on the Upchurch pottery, formed by parallel intersecting lines. In its shape, this vessel has much the appearance of a sepulchral urn. A considerable quantity of this pottery is without ornament at all. Among this unornamented pottery are found especially jug-shaped vessels, commonly with a handle, like that represented in the last figure in our plate. Two similar vessels are represented in our woodcut (8 and 9); in which I give also a curiously-shaped plain urn (7), and an unornamented vessel of another form (6).

At different spots over the locality which was covered by these potteries, Mr. Roach Smith has found remains which indicate the former existence of kilns, and further researches will most probably bring to light some of the kilns themselves. Traces have also been found of the residences and of the graves of the potters. There appears to have been a more extensive settlement—a potters' village, or little town—on the higher ground, bordering the marshes at Halstow. "In the Halstow marshes," Mr. Roach Smith observes, "I noticed, at a particular spot, a considerable quantity of tiles and stones, which I could not positively identify as having been used in buildings; but adjoining the church, near the creek, there are abundance of fragments of tiles of various kinds, that clearly show the locality to have been the site of buildings, which, if we may judge from their *débris*, must have been tolerably extensive. On the sides of the church, facing the creek, an embankment has been thrown up to protect the land from the sea; this defence is filled with broken tiles and pottery, which also literally cover the shores. The church itself, probably of Saxon origin, has a large quantity of Roman masonry worked into the walls, and in a field west of the church, in the side of a well sunk for water, for purposes of brick making, I noticed a tier of Roman tiles, which appeared to be part of a hypocaust."

CHACORNAC ON THE VOLCANOES OF THE SUN.

We have, in former numbers, made mention of M. Chacornac's solar observations at Ville-Urbanne, and of the theories which he has been led to form, and we are now indebted to him for a long paper on "The Structure and Origin of Solar Volcanoes." In the present condition of the sun, in which the production of spots is at a minimum, he informs us that the time is favourable for the study of *little spots* which frequently appear entirely destitute of a penumbra so long as their largest dimensions do not exceed five or six seconds of an arc, but which acquire one as they grow bigger. Referring to earlier observations, M. Chacornac informs us that he has drawings of 740 isolated spots not exceeding the dimensions just stated, and all destitute of any certain traces of a penumbra; while other spots, in closer aggregation or united by fissures, usually exhibit a portion of a penumbra generally corresponding with that part of the spot which is darkest and most deeply excavated. In this category must not be comprehended simple superficial fissures, which are themselves only isolated penumbra, and which appear of different degrees of shade from the intensity of certain nuclei to that of the general surface of the orb, or about a sixtieth below the surface. These are only variations in the level of the photosphere, and seem to occur in the most external layers of the immense luminous envelope of the sun. The causes which produce them appear to reside in the superficial layers, as it is only changes in the layers which underlie the photosphere that can give rise to such phenomena, and this fact, taken in connection with the rapid changes of form that are noticed on the solar surface, leads to the conclusion that we have to do with an immense atmosphere enveloping a central nucleus.

The phenomenon which should occupy the foremost place in any hypothesis is without doubt the rapidity of the precipitation of spots one in the other. Hence comes the relative movements of groups in different latitudes, and the appearance of fusion which characterises the formation of spots. All astronomers, for example, might remark the regular form of the great spot which entered the visible hemisphere during the night of the 7th—8th of last July, and the persistence of this form, which was nearly circular and without diminution, all the while the spot appeared, which was up to the 20th July at 6 P.M.; and they could also notice the irregularities of shape and the rapid changes exhibited by a single group which occupied the centre of the disc on the day last named.

The very rapid changes in this last group, M. Chacornac

thinks not consistent with the supposition of a liquid medium. It was evidently a cloudy or gaseous one, able, by sudden condensation, to form a relative vacuum, and occasion the precipitation of fresh atmospheric layers upon the photosphere, and the consequent formation of spots. Spiral gyratory movements indicated this kind of action. Moreover, the spots exhibited a disposition more or less striking to form gulfs, into which the photospheric matter descended.

In order to have superficial currents in a fluid spherical mass, it seems necessary that there should be a break in the decreasing density of its layers, and that there should be an abrupt transition, as in the case of the atmospheres of Jupiter, Saturn, or the Earth, which rest upon a solid surface, and likewise a cause for the variation of the temperature of its layers. From these and other considerations, M. Chacornac concludes that it is an atmosphere with which our observations have to do.

The nuclei, in which great and feebly-luminous depths are seen, disappear as if by evaporation—they dissipate themselves like atmospheric clouds. The same phenomena are exhibited in deep as in superficial layers, and who does not see in this order of facts an explanation of the immense cavities into which faculæ are precipitated in torrents. Nothing is more simple than these fusions and rapid falling of little spots into big ones. In the region in which a vacuum is made, that is to say in a spot, the cloudy layers are precipitated in the liquid form on to the surface of the central body, or perhaps these vapours in a vesicular state are vaporized and dissolved so as to occasion a vacuum in which the superior or adjacent layers are swallowed up.

M. Chacornac observes that the descending currents in these cases must have great force to draw with them, as he has seen, matters possessing a horizontal velocity of 550 mètres in a second.

The mobility of the spots and the rapidity of their changes are regarded by M. Chacornac as opposed to the conception of a resisting medium, and still more so to rents in a solid crust.

When a great spot is forming, all the surrounding parts are dragged into the gulf, into which also fall adjacent spots of small dimensions.

If a spot is solitary it assumes the regular form of a funnel, and the flocculent matter is distributed in channels round the whirlpool orifice (*orifice turbiné*).

M. Chacornac does not deny the existence of ascending currents, though what is observed only proves the operation of descending currents. All spots, for example, are cavities

with the narrow orifice downwards, and the forms of streams and ripples (*sillons*) of flocculent matter always indicate a descent of the upper layers into the regions below.

When a funnel-shaped gulf is formed by the sinking down of the atmospheric strata, there is a disturbance in the equilibrium of the flocculent masses, precipitation of adjacent layers into the orifice, and accumulation of vaporous matter at this part of the atmosphere, as is shown by the faculæ heaped up in the vicinity of a dark cavity. It seems as if this affluence of a vaporous fluid gave rise to a heaping up (*bourrelet*) of atmospheric masses round a dark spot. At the base of these mountains a fusion takes place, and when the changes are very rapid, lines of dislocation are observed, circumscribing the annular mountains, and rendering them top-heavy, so that they fall and give rise to a penumbra.

M. Chacornac describes a case in which a small spot approached a large one and fell into its penumbra, without lessening it or occasioning any other change than making a new orifice in its perimeter; and he likens the currents of photospheric matter to the cascades of Niagara, in which the form is preserved. After the examination of this fact, he affirms it to be impossible to regard the spots as occurring in a liquid medium, for he says we should ask how such masses of liquid could be volatilized without occasioning an immense conflagration when they were converted into gas? Immense photospheric clouds dissolve in a few hours, though their volume may be greater than that of the earth.

M. Chacornac considers that the hypothesis of solar volcanoes arising in a liquid medium cannot be maintained, as the phenomena can only be explained on the supposition of rapid currents occasioned by the formation of a vacuum. A *central* body in a liquid state would not, he thinks, be in contradiction to the general phenomena exhibited by the sun. It would be the source from which emanates that cloudy mass which constitutes the solar atmosphere of which the limiting layer is in a state of lively incandescence. According to this hypothesis the temperature decreases from the circumference to the centre, as the law of densities augmenting in the same direction demands. Varying degrees of heat and density in different strata, and the effect of the sun's rotation, would give rise to currents such as are seen in the trade winds, in the belts of Jupiter, and in the motions of sun spots, provided that the atmosphere is situated upon a solid body.

M. Chacornac thinks that the sun may consist of a central liquid covered with a solid pellicle, and surrounded by an atmosphere composed of several layers, which in their normal condition appear in contact and united. The pellicle,

or crust, is ruptured by volcanic action, and eruptive currents dissolve the photosphere.

This paper is an exceedingly difficult one to give an account of; but we have endeavoured to present our readers with its prominent ideas.

THE EXHIBITION OF MINIATURES AT THE SOUTH KENSINGTON MUSEUM.

BY W. M. ROSSETTI.

(*Concluded from our last.*)

In resuming our notice of this Exhibition, necessarily very far from exhaustive or complete, we come first to the

BRITISH PORTRAITS OF THE STUART PERIOD AND THE COMMONWEALTH.

Lady Arabella Stuart was, and deserved to be, frequently painted. In No. 486, by I. Oliver, she is not so pretty as in some other portraits, and tends to the Mongolian type of visage.—No. 1580, by the same, was painted at a somewhat later period of life than most of the portraits of this beautiful and ill-treated lady; here she has a melancholy look, instead of the blooming and exuberant air of the earlier likenesses, and one can guess that the iron has entered into her soul.—In No. 2169, by the same, "she is represented with her long auburn hair hanging on her shoulders, wearing a close lace falling collar or ruff, a pearl in one ear, and a black ribbon in the other."—A fourth likeness, by the same, "with a jewelled anchor as an ear-ring," is very charming.

Elizabeth Stuart, Queen of Bohemia, by the same, "is represented young, wearing an open lace ruff, over which her light auburn hair falls upon her shoulders and down to her waist;" a very agreeable portrait.—P. Oliver also has painted a fine miniature, the face not unlike that of the greater Elizabeth, "Good Queen Bess."

Lady Shirley, by Hilliard, "represented with her hair falling loose on her shoulders, and wearing a wreath of oak leaves," was a charming woman, who pretty evidently knew that fact, without losing the grace of being natural.—I. Oliver's version is also very handsome.

Frances Howard, Countess of Essex, ascribed to P. Oliver, an excellent portrait of Sir Thomas Overbury's poisoner, shows us a fine woman, with an open, unembarrassed counte-

nance, not such as one would be inclined to associate with her criminal career. She certainly, however, does not look as if opposition to her will would be very tolerantly received.—I. Oliver gives a face not wholly unlike that of Arabella Stuart, with a coquettish air, and broader.

Of *Charles I.*, one portrait, "formed of the King's hair dipped in his blood on the scaffold, belonged to John Winckley, who was executed at Lancaster Castle in 1716, with the Earl of Derwentwater, for the Jacobite rising of 1715."—Another, by Snelling, 1647, drawn with the brush on paper, is very careful and agreeable.—In Charles when young, by P. Oliver, it is difficult to trace the countenance so unmistakeable in after years.—Another portrait (painter anonymous), oil on copper, is a record of the king's later days, showing forcibly the points of resemblance to his father James I., and not much more noble-looking than that monarch. "It is said that, for some months before his death, the king refused to allow his beard to be cut. On the other side of the frame is a portrait of Bishop Juxon, his faithful servant and attendant upon the scaffold."

Venetia Lady Digby, 1633, by P. Oliver, after Vandyck. "Represented as she was found dead in her bed. She is mentioned by Lord Clarendon as 'of an extraordinary beauty and as extraordinary fame.'"

Old Parr, by Professor Way, of Stockholm (so marked by Mr. Crofton Croker). Copper. We know not in which of his 152 years this portrait of Old Parr may have been painted; he looks old enough to be some way past 100.

Oliver Cromwell, after S. Cooper, enamel, was a present made to Bridget Cromwell on her marriage with Ireton in 1646, and worn by her as a clasp to a bracelet; it is somewhat damaged in surface.—In the portrait by S. Cooper, 1657, the face has a striking expression of honesty, though the miniature is not one of Cooper's very best.—By the same, full-face to the right, is an important specimen, but also not of the painter's best.—Loggan's pencil likeness has a victorious look, yet somewhat "groggy," if so irreverent a term may be applied to any likeness of the hero.—In the "Profile drawing in pen and brown, tinted, by S. Cooper, from which Houbraken engraved his portrait" (paper), the expression is mild, possibly too much so, but it is a valuable likeness.—In No. 1472, by the same, the age is apparently about thirty-five; the face longer and thinner, and the nose more nearly straight than in most portraits.—No. 1873, painter anonymous, is a very small and clever miniature, giving a somewhat exceptional version of the face.—Another, in profile, by S. Cooper, "was sold by the Lady Cornwallis to Sir Joshua Reynolds for 100 guineas. He be-

queathed it to Mr. Richard Burke, who left it to Frances Lady Crewe, from whom it descended to her grand-daughter, the present Lady Houghton."

Richard Cromwell, 1649, by the same, exhibits a long, pale, hatchet-face.—The miniature by Hoskins, jun., 1659, together with one of Ireton, and an enamel of Oliver Cromwell, were the property of Bridget Cromwell (Mrs. Ireton), and afterwards of Elizabeth Ireton (Mrs. Polhill): the three have ever since remained in the possession of her lineal descendants. There is a curious look in Richard's face—or else one fancies it—of being the fool of the family.—S. Cooper, 1647, gives the sitter a thoughtful but ineffectual look.

Elizabeth Claypole, Cromwell's favourite daughter, by the same, 1653, is finely done, but rather deficient in corporal development.—A profile by the same, pencil, is rather a poor version of the face.

Mary, Countess of Falconberg, third daughter of Oliver Cromwell, by the same, a handsome woman, is a fine specimen of the painter.

Bridget Ireton, Cromwell's daughter, 1652, is also by the same.

General Ireton, 1649, by the same, shows a fine face, not wholly unlike that of Gaston de Foix.

General Charles Fleetwood, the second husband of Bridget Cromwell, 1656, is again by the same.

Sir Harry Vane the Younger, oil, has a strong, handsome face, worthy of the man.

Charles II., by Loggan, pencil, is one of the most interesting versions of the grim visage of the "Merry Monarch," showing some true family likeness to both his father and his mother.—S. Cooper's portrait, 1665, with the mantle and collar of the Order of the Garter, is large and rather unfinished, but very able.—Loggan's in black lead, "probably the original drawing from which Loggan engraved the published portrait," is also excellent.—No. 2032, Charles II. when young, painter anonymous, and No. 1014, catalogued simply as "Portrait of a gentleman," are duplicates.

Catharine of Braganza, Queen of Charles II., if her miniature is a true record of the neglected queen, looked of as easy virtue, and displayed her charms with as much liberality, as any of the beauties who competed for her husband's attentions.

James II. as Duke of York, by Petitot, is an enamel, very complete and actual. Here we find a true historic style in the very smallest dimensions.

Jacob Hall, the rope-dancer and comedian in the reign of Charles II., oil, must have been an exceedingly handsome

fellow, with the beauty almost of a woman, and the audacity of a man. One need not wonder at the favour he found among the easy fair ones of the period.

FOREIGN PORTRAITS UP TO THE REIGN OF LOUIS XIV.

Francis I., ascribed to Clouet, oil, gives a handsome version of the face, though, as always, extra French in its peculiarities.—In *Francis and the Duchesse d'Etampes*, by Luca Penni (oil, mounted in a crystal locket), the king is making love to his fair one, with Cupid to preside over the transaction. Very charming.

Charles V., in one of his likenesses, seems hardly more than twenty years of age, with a more aquiline cast of feature than in his later portraits.—Another, about 1520, is ascribed to Holbein.

Philip II. of Spain, by Luis de Vargas, 1555, oil, is a companion to the portrait of our Queen Mary, by the same painter; also very fine.—Another so-called Philip II., painter unnamed (No. 1281), appears to us extremely questionable.

Calvin, by Holbein. Oil. We have some doubt of the authorship of this portrait. Calvin is here presented as a young or youngish man; the nose long, with no aquiline tendency, the eyes blueish grey, the complexion light, the expression reflective.

Catharine de' Medici, inscribed "B—56—1581," oil, has here a sort of motherly look, though not of a noble type. The inscription suggests a fib on her part, or else flattery on the part of the artist, for she was 62 years old, instead of 56, in 1581.

Admiral de Coligni, by I. Oliver, is a perfect small specimen of the best class of miniature-painting.

The Duc d'Anjou, the suitor of Queen Elizabeth, half length, constitutes a largeish miniature. The duke has a somewhat meagre and hungry aspect, but is not so ugly as tradition reports him.—Clouet's version, "holding what is supposed to be a miniature of the Queen in his right hand," oil on copper, is an excellent portrait, giving the duke something of a "fast" look.

FOREIGN PORTRAITS FROM THE REIGN OF LOUIS XIV. ONWARDS.

Louis XIV. as a boy, by Petitot. Enamel.—The same, when young, by Petitot. Enamel. (No. 1185.) These are two out of a huge number of likenesses of the Grand Monarque, by this famous enamel-painter, and other artists. No. 1185 is remarkably perfect in execution, and gives a handsome version of the face.

The Duchesse de la Vallière, by the same. Enamel.—Another, anonymous, very loveable.—A snuff-box, "exquisitely enamelled, with the top, bottom, and sides ornamented with beautiful portrait-miniatures of the celebrated beauties of the Court of Louis XIV. The medallion on the top of the box represents la Duchesse de la Vallière in the centre; la Duchesse de Fontagnes to the right; Madame de Maintenon to the left. The medallion on the bottom represents Hortense de Mancini, Duchesse de Mazarin, in the centre; la Marquise de Montespan to the right; Mdlle. Dupré, "la belle jardinière de Meudon," to the left. The medallion in front, la Duchesse de Brissac in the centre; Mdlle. de Blois, Princesse de Conti, fille de la Duchesse de la Vallière, to the right; la Contesse de Grignan, fille de Madame de Sévigné, to the left. The medallion at the back, la Duchesse de Nevers in the centre, the sister, and la Duchesse de Sforce to the right, the niece of la Marquise de Montespan; Henriette de Coligni, Contesse de la Suze, to the left. The medallion at the right end represents Ninon de l'Enclos in a green dress. The medallion at the left end is a portrait unknown. This beautiful work of art was formerly in the cabinet of the Marquis de la Reignère" (now of Mr. George Bonner).

Madame de Maintenon, by the same, enamel, appears to be about the age of twenty-three. Very lovely and engaging—more so than any other portrait we know of this lady.

The Regent Duke of Orleans. One of the enamels of this famous debauchee, No. 819, is catalogued as "Philippe d'Orleans, Regent of France, and brother of Louis XIV" (!) So absurd a historical blunder ought not to have been let pass. Indeed, we must say, while making every allowance for the difficulties of various kinds which, no doubt, beset the compiler, that the catalogue is not free from some considerable blemishes. The information given under one heading is continually repeated under another; and this information, even when not incorrect, as in the present instance, is too often twaddling or supererogatory. Here are two or three specimens: "Robert Devereux, Earl of Essex, 1567—1621 [should be 1601]. The favourite of Elizabeth, and the hero of the romantic story of a ring entrusted by him to the Countess of Nottingham, the non-delivery of which was supposed to have consigned him to the scaffold." "Armand Jean du Plessis, Cardinal Richelieu, 1585—1642. A celebrated French Minister in the time of Louis XIII., and well known for his persecution of the Huguenots." No. 1016, catalogued merely as "Portrait of a Gentleman," is, in fact, a copy of a well-known female head by Greuze. "Paul Rembrandt van Ryn, an eminent Dutch painter and etcher." "William Cecil, Lord Burleigh, 1520—

1598, Lord High Treasurer and Secretary of State to Queen Elizabeth. He is said to have had a principal share in the administration for upwards of forty years." "Horace Walpole, the well-known literary character of the last century." Nos. 1859—60 are recklessly catalogued as "Earl and Countess of Kildare, 1734. Oil. Ascribed to Hans Holbein;" whereas the costume is about one hundred years later than the date of Holbein's death, 1543. "George Monk, Duke of Albemarle, a distinguished military and naval commander in the Civil Wars during the reign of King Charles II." (!) Titian, who died in 1576, is credited with a portrait, at a mature age, termed Galileo, who was born in 1564, and which presents very little resemblance to that philosopher. "H.R.H. the Princess Marie Amalie, sister of Louis Philippe," should be "Madame Adélaïde," the name given in the catalogue being that of Louis Philippe's *wife*, the venerable ex-Queen of the French, still surviving.

The Empress Catharine II. of Russia, given by herself to W. Fawkener, when on a mission to Russia in 1791, is one of the best portraits of the Empress, apparently about the age of thirty-two: a face as of marble that would yield to the touch. —In Boit's enamel, somewhere about the same age, the Empress is represented with her brown hair unpowdered, and with a somewhat jolly and vulgar look.—She reappears "in the dress (a semi-masculine one) she wore in the Crimea in 1787,"—and again, "a great likeness," towards the age of sixty-five.

The Emperor Paul of Russia presents one of the most grotesque faces ever invented by the arch-caricaturist nature; something between the popular idea of Robespierre and a skull, simpering.

The Chevalier d'Eon. "A notorious character in the last century," says the catalogue, "who for many years passed himself off for a woman." We are not aware whether many people in England know that the most elaborate of the Chevalier's biographers declares him to have been the father of our late beloved sovereign George IV.! Let us add that the evidence adduced to sustain this astounding hypothesis is no evidence at all, and scarcely, even supposing it to be accurate, amounts to a faint suggestion or suspicion. In this portrait the Chevalier appears in his female garb, and, without being handsome, makes a good-looking woman enough.

PORTRAITS ILLUSTRATIVE OF THE FRENCH REVOLUTION AND FIRST EMPIRE.

Marie Antoinette. Among various portraits of this Queen, the most interesting, from its associations, is one by Ströhling

(No. 2189), belonging to a set of five, labelled "Presented (No. 3 excepted) by Queen Marie Antoinette to her foster-brother the Chevalier Weber."

Madame Elizabeth belongs to the same set. Unless this is a flattering likeness, the true-souled sister of Louis XVI., the one of the guillotined royal trio whom one can most unreservedly pity and commend, was an extremely pretty woman.

The *Princesse de Lamballe* was painted at full length, seated, by Sicardi, approaching in size the miniatures of our Thorburn.—We have always been taught to speak of "the lovely Princesse de Lamballe." That lady can have looked with little favour upon the painter of another of her portraits (anonymous) who has made her almost "a guy."—Hall gives a very different version of the face, partaking of the chubby and cherubic.

The miniature of *Robespierre* is a very interesting record of the best-abused man of the last hundred years, but whom some few people have by this time found out to rank among the heroes, and some, still fewer, among the benefactors, of the world's history. It is a well-painted portrait, and looks as if its evidence might be trusted as far as it goes. The face is an unmistakeably clever one, with something of the smile and aspect of Voltaire, and a great air of self-confidence, trenching upon self-applause. There is a direct look in the eyes, not at all suggesting an abject or malignant nature; both they and the eyebrows are dark, the hair powdered, the costume neither dandified nor slovenly. This portrait does not in any degree confirm Carlyle's famous term for Robespierre, "seagreen incorruptible;" on the contrary, the complexion is full-coloured, tending towards sanguine.

Murat furnishes a head-and-shoulders portrait, done on a largeish scale for a miniature. He looks an "ugly customer" for anybody to argue with or make an impression upon.

Camille des Moulins, by Augustin. A face which testifies to its owner's brilliant talent.

Napoleon I., by Isabey, is one of the best-known likenesses of the Imperial time.—The same, painter anonymous, "given by Marshal Soult to Sir William Napier," is a rather poor, "soppy" version of this magnificent head, about the age of forty-five.—Of a crayon study by Longhi, "an autograph letter of the artist says that this portrait was taken while Napoleon, then First Consul, was hearing a prolix address in the Cathedral of Milan." It is a profile, pretty fair.—Napoleon, "when young," by Isabey, is but a poor treatment, and the age does not seem to be particularly "young," but about forty. The miniature was presented by Napoleon's venerable mother to

his physician at St. Helena, O'Meara.—The same, ascribed to Isabey, rather an overdone version, and not of the best, was presented by Napoleon "to one of his Marshals before the Russian campaign in 1812. The seal is the original one of the letter of presentation to the Marshal."—The same, signed "M, 1815," "mounted in a round, gold-lined snuff-box, was given by the Emperor to one of his Marshals during the Hundred Days."

The Empress Josephine, by Vandenberg, 1800, is a very unflattering portrait. Josephine was thirty-seven years of age in 1800, and passed for being younger: here she looks more like fifty.

Lady Hamilton, with her hair and initials at the back, painted probably during her residence in Naples. This miniature was worn by Nelson at the battle of Trafalgar, and was taken from his neck after his death.

Wellington, by Isabey, 1816.

General Acton, the Minister of Naples. There is nothing very noticeable in the face of this celebrated intriguer: one would have expected something more decisive, to mark the man.

Madame Récamier, by Isabey. This celebrated beauty and queen of the Parisian salons seems, by the present portrait, to have had too large a head, and singularly small arms. The air of grace is nevertheless preserved.

BRITISH PORTRAITS FROM THE REIGN OF QUEEN ANNE, ONWARDS.

Lady Arabella Fermor, the heroine of Pope's "Rape of the Lock." Oil. "She gave this portrait to one of the Wakemans, and at the same time refused his proposal."

The Coalition, *Lord North and Charles Fox,* enamel, is an amusing grotesque: a coalition-face, one half being proper to the North and the other to the Fox visage.

Mr. O'Hara, by Pompeo Battoni, is very perfect for style and the look of life. It is seldom, so far as we know, that this distinguished painter, originally a goldsmith, appears as a miniaturist.

George IV., as Prince of Wales, by Cosway. The remarkable good looks of the prince in his youth, approaching to handsomeness, but not entirely transcending prettiness, are fully brought out in this likeness, among others.

In the *Mrs. Fitzherbert,* by Cosway, this lady, so much talked of on account of her private marriage to the Prince, afterwards George IV., is represented as somewhat *passée,* and with a cast of countenance not unlike Mrs. Siddons.—The Exhibition contains also the Wedding-Ring of the Prince and

Mrs. Fitzherbert—"a gimmal ring, with the name George Augustus Frederick engraved within the hoop;" the eye of Mrs. Fitzherbert, represented in miniature upon a vapoury ground; and a similar painting of the eye of the Prince of Wales, set in a ring.—Another portrait of Mrs. Fitzherbert, by Cosway, 1788, is younger than the one first-named, and much prettier, though the features are rather large.

Mrs. Siddons, by Edridge.—By T. Harding. About the age of sixty, with an air of tragedy in private life.—By Cosway, before 1784. Of almost Jewish aspect.—Mrs. Siddons in the character of Zara, drawn by Lawrence when only twelve years old. Crayons.

Mrs. Robinson, "Perdita," in the manner of Shelley, but ascribed to Cosway, looks very much as if she were determined to set her cap at any and every eligible man, and perhaps she was so. This (No. 739) is a duplicate of No. 2592, catalogued as "Portrait of a lady unknown, by Michael Keene."

Mrs. Bayly, 1773, is a charming portrait, somewhere between the styles of the elder miniaturists, of Cosway, and of his successor Ross. The experts ought to identify the author, and give him the credit of his work.

Lady Carteret and Lady Caroline Moreland, by Cosway, present a good example of Cosway's style; partaking at once of the pale clearness and simplicity of the older miniatures, and of the vivacious, *dégagé* air which is more especially modern.

Two Ladies, by the same (Nos. 1420—21), also furnish a characteristic example of the painter. He is often charming, and always in good taste, and in colour inclines mostly to modest and greyish tints. A tendency to flattery, however, is unmistakeable, along with some extra coquetry of hair, drapery, etc.

AUTHORS, PHILOSOPHERS, ETC.

Erasmus, ascribed to I. Oliver, if really by Oliver, must, according to chronology, be a copy. It is a youthful likeness, some twenty-four years of age.

Spenser, by Hilliard, is a small picture, which seems to have been retouched. The face has a sufficiently individual look, but is wanting in prominence.

In *Bacon*, by P. Oliver, inscribed "Anno Dni. 1620, Ætatis suæ 60," the hair is still abundant and perfectly brown.—No. 2662, ascribed to the same painter, appears certainly to be not good enough.

Lady Mary Wortley Montague, in tho costume worn by her in Turkey, is a three-quarters figure excellently painted: a slight greyish or greenish tint in the flesh-shadows suggests that it may be by a French artist.

Percy Bysshe Shelley, by Easton, "from the original in oil by Miss Curran, painted in Rome, 1819, now at Boxcombe," is the well-known version—almost the only one extant, we believe—of the divine face of this most divine poet and man. Shelley was twenty-six years of age in 1819, whereas this looks more like eighteen; but his extreme juvenility of aspect is attested from many quarters.

Alfred Tennyson, about twenty, by Miss Dixon, is the portrait engraved in Horne's "New Spirit of the Age." It can scarcely be supposed to do justice to the early youth of so noble a face as Tennyson's, but it is none the less of considerable interest.

PAINTERS.

Michael Angelo and Giulio Romano, by Sebastian del Piombo, oil, is a very fine work. Michael Angelo is represented at the age of about fifty; his countenance very Italian in type and somewhat haggard, his hair black, just beginning to grizzle. Giulio Romano, who was thirty-two when Michael Angelo was fifty, here looks nearer forty, and the head does not strike us as much like other known portraits of the painter.

Jacopo Tintoretto, by himself. Oil, on copper. This capital portrait represents the great painter evidently at a very early age, hardly perhaps past fifteen. If really a portrait of Tintoretto, it is singularly interesting; we should like to know whether there is any clear authentication of it forthcoming.

Holbein, by himself, oil, is an interesting portrait, at about the age of thirty-two, with a direct discerning look.

Nicholas Hilliard's portrait has been copied by G. P. Harding, from the original by Hilliard, in the collection of Lord de l'Isle and Dudley. The admirable miniature-painter appears from this record to have had the handsome and courtly aspect so well appreciated by his sovereign mistress Queen Elizabeth; there is a true touch of the artist as well.

Velasquez, by himself, oil on copper, presents a splendid record of the thin long face of this great master.

Rembrandt, by himself, oil, is a clever portrait of very early youth, hardly perhaps exceeding the age of sixteen.

Samuel Palmer, 1829, by George Richmond. The admirers of the poetical landscapes of this water-colour painter will be pleased to see so handsome and troubadour-like a head of him in his youthful prime.

"*Portraits*" (No. 3080)—*the Artist and his Wife*, by Wells, shows, with great typical completeness, the highest development of subject, scale, and execution to which miniature art had attained in the final years of its prosperity: many

visitors will remember the picture's appearance in the Academy exhibition of some seven or eight years ago. It is a regular portrait-picture subject, with three figures—the painter, his wife seated on a donkey, and the Italian donkey-boy—and a landscape background. We have already assigned some reasons for thinking that the simple conception of miniature art in its earlier years was the truer one; but this picture by Mr. Wells may fairly be cited by opponents as an argument to the contrary. It makes us hope, at any rate, that the condition of the art will, within Mr. Wells's lifetime, again become such as to permit of his devoting to it a considerable share of his time and abilities. The miniature here before us is in every way interesting; as, besides being a leading specimen of the art in its latest range, it contains true and valuable portraiture, not only of the artist himself, but of his wife, a painter of quite singular genius among women, snatched away, by early death, from a career which could not but have been distinguished, and eminently encouraging to her sister-practitioners in the art.

MISCELLANEOUS PORTRAITS, CONTEMPORARY OR QUASI CONTEMPORARY.

The Princess Royal, as a child, 1845, by Ross; offers an elegant example of this excellent miniaturist.

Lady Banks, by the same, is also a fine specimen of the painter, who has here had as subject the extreme of healthy, almost rustic, comeliness in a lady.

The Countess of Shaftesbury (then Lady Ashley), about 1834, by the same, is a very good specimen, pure and unlaboured, with a tinge, in point of expression, of the then still partly dominant style of Lawrence.

Two Children of Mrs. Pollen, by the same, is the well-known and admired miniature in which a girl clasps her little brother round the neck. While delicate in flesh-painting, there is rather too decided a touch of Lawrence in the feeling of the group.

The Artist's Children, by Linnell, sen., 1824. The present generation of exhibition-visitors has almost forgotten that Linnell, one of their most cherished artists as a landscapist, was originally a portrait-painter. This miniature, in which the children are revelling in the society of a kitten, is remarkable for its rounded relief, the extreme reverse of the old school of miniature art. It has conspicuous merit notwithstanding.

The Countess of Chesterfield and Lady Evelyn Stanhope, by Thorburn. We all remember the impression which Thorburn's large miniatures, highly wrought in execution and in their feeling for beauty and elegance, used to produce year after

year at the Royal Academy up to some ten years ago. This is one of the most adequate examples of his elaborate style included in the present exhibition; we should have expected to find a fuller representation of so admired a miniaturist.

"*Alice*," by Wells, is an excellent miniature, showing the best attainment of the modern school; not unlike the works of Ross, but with greater force.

With this example we bid adieu to the exhibition; only regretting that we have been compelled to mention much fewer works, and those much more summarily, than the number, importance, and interest of the specimens displayed would demand. Our limits of space have compelled us to omit several names of sitters no less distinguished than Queen Henrietta Maria, Strafford, Hampden, Algernon Sidney, Henri IV., Sully, Condé, Turenne, Charles XII., Peter the Great, Maria Theresa, Frederick the Great, Lafayette, Talleyrand, Nelson, Marlborough, the elder Pitt, Clive, Warren Hastings, Washington, Montaigne, Lope de Vega, Ben Jonson, Milton, Corneille, Molière, Dryden, Newton, Pope, Swift, Voltaire, Kant, Scott, Byron, Raphael, Rubens, Wren, Handel, Reynolds, Flaxman, Wilkie, and Napoleon III.

REMARKS ON THE STRUCTURE AND ACTIONS OF THE IRIS OF THE EYE IN SOME SPECIES OF FISHES.

BY JONATHAN COUCH, F.L.S., ETC.

The eyes of fishes differ in a remarkable degree from those of quadrupeds, birds, and reptiles, and especially in the want of a power by which the amount of light to be admitted may be regulated; and in consequence of what has been noticed of this, that portion of the eye of this class of animals which is termed the Iris has from the earliest times been considered as merely an immovable curtain or diaphragm, altogether incapable of contraction or dilation. In the second volume of *Loudon's Magazine of Natural History*, new series, Mr. Dalrymple remarks that he was never able to discover the slightest movement in this portion of the eye, and after many attentive observations on the cod family, the gurnards, and several others, I have arrived at the same conclusion. As regards the smooth blenny, or shanny, in particular, they have been subjected to the inquiry when at liberty in their native pools, where they were enticed by baits placed at different distances, to which they are never indifferent; but while looking at these

tempting objects, even at the distance of fourteen feet or nearer, no motion of the iris was perceptible; nor was there any change when the fish has been removed from the water into bright sunshine. The living young of the picked dogfish have also been taken from the body of the parent and exposed to the glare of a bright sunshine without any sensible effect on the iris; and when several examples of different kinds of fishes were examined, in order to ascertain whether some difference in the extent of this organ might be discerned in one or other of the several species, the result was that nothing further could be detected than might be looked for in the difference of size or other particulars of the same sort. But the result of our inquiry was somewhat different when the inquiry was extended to the species of the sharks and rays. But first, in the flat fishes, or *Pleuronectidæ,* the line of vision is not directed upward, as is often represented in the stuffed examples of museums and in many engravings; but the eyes are raised above the surface, and directed laterally, so that vision is protected from the glare of too much light, and the upper portion of the iris is so far bent downward as sometimes to serve the purpose of a partial screen; but still without the power of motion or contraction; while in the depressed section of cartilaginous fishes, or the rays and skates, this upper portion of the iris not only receives a new shape, but it is endued with a new property, which has an influence on the further modification of the eye itself, or the particular function of sight. The curtain, or veil, which hangs down from the upper portion of the iris is, in fact, a covering to the superior border of the pupil, for which it serves a use that has been particularly pointed out in our *History of the Fishes of the British Islands;* but it is to a peculiar structure of this portion of the eye in these fishes that I wish to direct particular attention. On attentive examination of this portion of the iris of these fishes, it is seen that on the anterior portion the surface is smooth, and not, as in birds, striated and irregular; but in its substance the texture is loose, and viewed under a microscope it appears to be composed of an exceedingly fine, but irregular network, which is not composed solely of vessels, but is more loose about the middle distance between the pupil, or inner border of the iris, and its outer circumference; and it becomes more condensed as it approaches the pupil in one direction and the circumference on the other. At what may be termed the border of the pupil there is a condensed rim of the same texture, so that the iris itself has a finely granular appearance, and the condensation is directed along even the border of the fringes of the dependent curtain; which portion of the iris, if we may judge from the difference of appearance it

presents at different times, possesses a power of dilation, or extension and contraction. In some examples of the fishes on which these observations were made, the curtain was only let down sufficiently to hide half the space of the pupil, while in others little of it could be seen until it was brought down into sight by the aid of the point of a needle, and again in others it extended so far as to shut up the whole of the pupil, except what could be discerned between the intervals of the fringe.

And not only do these curtains present a different appearance in different individuals, but even in the same fish this extension of the curtain shall be widely different in each eye, so that in one it shall almost entirely cover the sight, and in the other it may be scarcely capable of being discovered; a circumstance which goes far to show that the eyes of at least many fishes have a power of vision independent of each other, in a manner or to an extent wholly unlike what we perceive in ourselves, or in any animal of the land. The muscle discovered by Mr. Dalrymple, which influences the position of the crystalline lens of the eye, is present in that organ in the *Pleuronectidæ*, and also in the rays; but the curtain we have described appears to be the more required in the last-named fishes, from the circumstance that their range of action is often from a considerable depth of water, at the bottom to the broad daylight of the surface.

In the toper, the pupil is simple, without those appendages which we observe in the rays, and in its form transversely ovoid, furrowed on the surface, and in some examples much larger than in others. A remarkable circumstance connected with the eye of this fish is, that if, when newly taken from its native element, it be laid on its side in such a manner as to keep one of its eyes altogether out of the influence of light, the pupil of the darkened eye will become dilated, while, if the light be strong, the other will become contracted into an irregular line, and folds will be discerned in it, radiating more especially to the inferior border, and yet, on its anterior surface, there could not be seen any appearance of fibres, nor any special organization beyond the folds produced by the contraction, which were of a radiating and not a circular character, and those were for the most part near the margin of the pupil. Something similar to this occurs also in the picked dog, but there is so far a difference that the pupil in this species is perpendicularly ovoid instead of being transverse, and there is no regularity of action in its contraction and dilation as regards the comparison of one with the other, but each of them claims an entire independency, so that uniformity between them is altogether a matter of accident.

But however difficult it might be found to discover the muscular fibres of the eyes of these fishes while they were

alive, their action proved that they certainly existed, and further research in the dead subject became, therefore, necessary. With much care the iris of the eye of a toper was removed from its adhesion to the choroid, and placed smoothly on a piece of glass; when the radiating fibres could be as readily distinguished as usually in the human eye. It was then placed in water, where it was allowed to macerate for a few hours, and then the aqueous membrane was easily peeled off, and the pigmentum nigrum removed by agitating the fluid. Thus cleansed from their covering these radiating fibres were rendered far more distinct, and there was perceived also the very faint resemblance of a cœrulean band at the margin of the pupil. When the preparation thus formed had become dry the radiating fibres became much more distinct, and at this time also the circular band was rendered as clearly marked as the radiating fibres themselves, although no fibres could be discerned within it.

It is proper to add, as a melancholy tribute to his memory, that a large portion of these observations were made by my late son Richard Quiller Couch, of Penzance, at the time when he had not yet left his home at Polperro.

NOTES ON FUNGI.—No. IV.

BY THE REV. M. J. BERKELEY, M.A., F.L.S.

ROSE-SPORED MUSHROOMS.

(*With a Coloured Plate.*)

I HAVE already pointed out that a single species with decidedly rose-coloured spores, *Agaricus euosmos*, occurs in the white-spored series, but its affinities with the common Oyster Mushroom, *A. ostreatus*, are so intimate, that it would be in direct opposition to nature to separate them. The series respecting which I am now about to make some observations is extremely natural, and the species are not likely to be confounded with any in the remaining divisions. One species alone, *A. cretaceus*, a near ally of the common mushroom, might be sought for amongst the rose-spored Agarics (*Hyporhodii*), as its spores are very pale; indeed, so pale that there is occasional danger of its being referred on a superficial glance to *Lepiota*, especially as its gills are at length remote, as in several species of that subgenus. The spores of *Hyporhodii* assume two distinct forms: in one they are perfectly

even and regular, though wider on the outer side of the major axis than the inner; in the other they are altogether irregular, with three or four obtuse angles, and a large distinct nucleus.

The subgenera of *Hyporhodii* are the following—*Volvaria, Pluteus, Entoloma, Clitopilus, Leptonia, Nolanea, Eccilia.* The two first of these have the gills absolutely free; in the remaining divisions they are variously attached, though sometimes very slightly, and often separating from the stem at maturity.

The first subgenus, *Volvaria,* which derives its name from the volva being developed as strongly as in the most noble *Amanitæ,* and whose species in many respects approach *Agaricus cæsareus,* figured in the number of the INTELLECTUAL OBSERVER for April, 1865, No. 39, contains a few very fine species. The hymenophorum is perfectly distinct from the stem, and though the universal volva is so highly developed, there is no partial ring, a peculiarity which is observable in the whole of the series. The gills are regularly rounded behind, and sometimes they almost adhere together like the gills of *Coprini,* in consequence of the high development of the cysts which are scattered over them. They are moreover inclined to be deliquescent, and agree with the fugitive *Coprini* in their affecting richly-manured spots, very decayed wood, or fermenting vegetable matter, as tan. They are not in general reckoned esculents, though *Agarius parvulus,* which abounds in rich grassy pastures, often gets into the mushroom basket, either wilfully or accidentally. Viviani seems to think that all the species of this subgenus are esculent, but he very wisely adds a caution that we must wait for experience till we make any positive assertion in the matter.

Agaricus volvaceus sometimes grows in great abundance on spent tan in hothouses, and one or two closely allied species, but with a viscid pileus, occur now and then on the sides of pathways. *Agaricus coffeæ,* Viviani, has been found only on coffee-grounds left to ferment for some months in a stove in the botanic garden at Genoa. Another mushroom, *A. Neapolitanus,* which is of a beautiful snowy white, and not like the last reddish and streaked with darker lines, and apparently of very different affinity, as the gills are very decurrent and there is no mention of a volva, is procured in some quantity at Naples in a similar way, and is constantly eaten. The coffee-grounds are put into an earthern unvarnished vessel, which is placed in the shade and slightly watered occasionally, and the fungi appear at the end of six months. I tried more than thirty years ago to obtain it in the same way in England, but was not successful, perhaps from not having a sufficient quantity of coffee marc at my disposal.

FUNGI.

1.—Agaricus [illegible], Fr. var.
2.—Agaricus flammans, Fr.
3.—Agaricus albo-cyaneus, Desm.
4.—Agaricus appendiculatus, Bull.

5.—Agaricus [illegible]baceus, Bu[illegible]
6.—Russula emetica, Fr.
7.—Mitrula paludosa, Fr.

A very curious species, *A. bombycinus,* occurs now and then on very rotten wood of elm, lime, etc., and is remarkable for its silky pileus and very dark-lobed, sometimes almost viscid, volva. I must mention another species, *A. Loveianus,* because of its singular habit. It grows parasitically on decaying *A. nebularis,* and, with its snow-white silky pileus, ample volva, and rose-coloured gills, is extremely beautiful. It was first noticed in the journal of a naturalist by Mr. Knapp, under the name of *A. surrectus.* Figures of this, *A. bombycinus* and the viscid *A. speciosus,* will be found in the *Outlines of British Fungology.*

It is time, however, to go on to the next subgenus, *Pluteus,* which derives its name from a Latin word signifying the sloping covering which protects parties working a battering ram. It differs only from *Volvaria* in the total absence of a volva, the pileus, gills, and stem being quite of the same nature. The species grow on decayed trunks of trees, saw-dust, or on ground consisting very largely of decomposed wood. None of the species are considered esculent. The gills are sometimes yellow at first, but soon become pink from the spores. Many of them are very pretty, and *A. leoninus,* figured in the *Outlines,* when brightly coloured, with its deep scarlet pileus and pure yellow stem, is one of the very handsomest Agarics I ever met with. The pileus in this subgenus is sometimes silky, sometimes smooth, and in *A. phlebophorus* the cuticle is singularly wrinkled. *A. petasatus,* which occurs sometimes abundantly on large heaps of sawdust near sawmills or in cellars, is a most magnificent species.

Entoloma (from 'εντὸς, within; and λωμα, a veil), the veil being potential rather than definite, comprises several species belonging to three distinct groups, distinguished by their gills, which are often nearly free or slightly adnexed, being sinuated behind, while the margin of the pileus is at first inflexed. The stem is of a fibrous, fleshy consistence, or occasionally waxy. The more typical species often attain a large size. None, however, are admitted as articles of food, though it is possible that some which have a mealy scent may be wholesome, while in others a nitrous odour indicates unwholesome or suspicious properties. One of the early species, it is not exactly known which, has nearly proved fatal, and experiments therefore should be made with some caution. The three sections are distinguished as follows:— 1. Those with a fleshy pileus, smooth when full grown, often viscid but not hygrophanous, and never innato-floccose, or squamulose. 2. Those with a dry, flocculose, or slightly scaly pileus. 3. Species with a thin, hygrophanous, smooth pileus, which has however a silky lustre. All the species grow on the

ground, and while some occur in shady woods, others are found in the most exposed pastures. A figure of *A. clypeatus*, which belongs to the third section, will be found in the *Outlines*. In this, as in all the remaining subgenera of the series, the stem is confluent with the hymenophorum.

The next subgenus, *Clitopilus* (from κλίνω, I incline; and πῖλος, the pileus), is distinguished from the last by its decurrent gills, which are never sinuated behind. It contains a few species only, but one or two of these are of excellent quality, and much admired by fungophagists. We have but three species, of which *A. mundulus* is rare; *A. prunulus*, on the contrary, very common in woods or on their borders, and is excellent either stewed or pickled. The figure in the *Outlines* is not so characteristic as might be wished, but there can be no difficulty in distinguishing the species which, besides its decurrent rose-coloured gills, is known by its dull pruinose white or slightly cinereous pileus, and decidedly mealy scent.

The remaining subgenera contain only small species, which are often remarkable for beauty of colouring and elegance of form, but are too insignificant in other respects, if any of them are wholesome, to be of any economical importance.

Leptonia (from λεπτὸς, slender) bears the same relation to *Clitopilus*, that *Collybia* does to *Clitocybi*. The rigid cartilaginous stem, which is often tinged with blue, is the distinguishing mark, while the gills are never truly decurrent, though they may have a decurrent tooth. The margin is incurved, and the cuticle always broken up into scales. The flesh is always thin, and the pileus often umbilicate. They grow in rainy seasons on exposed pastures, of which, together with the bright-coloured *Hygrophori*, they are a distinguishing ornament in autumn. The sections are characterized by the primitive colour of the gills, without paying attention to which it is impossible to determine the species accurately. They may at first be either dirty white, blue, yellowish or green, grey or glaucous. They often separate from the stem when fully developed. *A. serrulatus*, which is one of the most singular, is distinguished by the black, finely-notched edge of the gills. The green-stemmed variety of *A. incanus*, figured in our second coloured plate of fungi (Fig. 1), which is sometimes very abundant, and is somewhat analogous in point of colouring to *Hygrophorus psittacinus*, is remarkable for its strong odour, resembling exactly that of mice.

Nolanea (from *nola*, a bell), like *Leptonia*, has a cartilaginous stem, but the margin of the campanulate pileus is straight and not incurved. The pileus, moreover, is not umbilicate, and the gills are not decurrent. *A. pascuus* is the most com-

mon species (more common perhaps in Scotland than in England), and may be known from some other allied forms by its gills being much attenuated behind. It is, however, extremely variable. But few species have been distinguished in this country. One of the most remarkable is *A. Babingtonii*, which has the grey shining pileus adorned with dark-brown little tufts of fibres which are free at one end, and a somewhat strigose stem. *A. rubidus*, a very small species figured in the first volume of the *Magazine of Zoology and Botany*, occurs occasionally on soil in hothouses, but whether really indigenous or not I am unable to say.

There remains only the small subgenus, *Eccilia* (from ἔκκοιλος, hollow inwardly), which is distinguished by the truly decurrent gills and umbilicate pileus. Like *Leptonia*, it has the margin of the pileus incurved. A very beautiful species lately figured in the *Annals of Natural History*, occurred at Aboyne, the subgenus being previously unrepresented in this country.

DESCRIPTION OF PLATE.

Besides *Agaricus incanus*, Fr., which has already been adverted to in the present paper, the following species, to which reference will be made in future notices, are figured in the coloured plate.

2. *Agaricus* (*Pholiota*) *flammans*, Fr., a very beautiful species, especially in a young state, which occurs in pine woods in Scotland, attached to fallen branches, and is distinguished by its bright yellow pileus, clothed with superficial hairy scales; its rough stem and yellow entire gills.

3. *Agaricus* (*Psalliota*) *albo-cyaneus*, Desm., a species which occurs in grassy pastures, and is very nearly related to the common *A. æruginosus*, but is far more delicate, and free from scales, as is also the stem; the gills, moreover, are not so decidedly adnate.

4. *Agaricus* (*Hypholoma*) *appendiculatus*, Bull. This is a very widely diffused Agaric, assuming various forms, but always known in its subgenus by the white veil being attached in fragments to the margin, while the gills are at first whitish and then rosy-brown. It occurs either on old stumps, or on soil where chips have been rotting.

5. *Agaricus* (*Psilocybe*) *bullaceus*, Bull. This Agaric grows principally on horse-dung, and when not washed by rain is pretty in form and colour. The pileus is hemispherical, very smooth, but finely striate in the direction of the gills; the stem is short, and more or less fibrillose, and the gills are of a ferruginous brown, very broad, and triangular.

6. *Russula emetica*, Fr., remarkable for its splendid polished

scarlet pileus, with a separable cuticle, and white equal free gills. As the name implies, it is a very dangerous fungus.

7. *Mitrula paludosa*, Fr. One of our most beautiful fungi, always occurring in very moist places, and generally on decaying leaves. Though clavate, it is totally different in structure from the true *Clavariæ*.

ON THE CHANGE OF PLUMAGE IN THE COMMON CROSSBILL (LOXIA CURVIROSTRA), WITH A FEW REMARKS ON THEIR BREEDING AND OTHER HABITS.

BY "AN OLD BUSHMAN."

THE subject of the change of plumage in birds, whether by a regular or a partial moult, is one of the greatest interest to the naturalist, and in the class of birds of which we are now treating, and which undergo so marked a change, from the dull green nest plumage to the bright scarlet livery of the adult male, there has always existed a doubt in the minds of naturalists as to the age of the bird in which this bright red plumage is obtained. Most naturalists, I believe, leant to the opinion that this dress was assumed in both the crossbills and the pine grosbeak on the *first* moult. I always had my doubts as to this, and an attentive study of both birds in a state of nature, and a careful examination of some hundred specimens of each, in every intermediate stage of plumage between the nest dress and the old bright yellow green of the very old bird, has proved satisfactorily to me that the bright crimson dress in neither is assumed at the first autumnal moult, and probably not till the third, and that in the crossbills especially the male bird undergoes several changes before this red livery is complete.

No one has perhaps had better opportunities of studying the habits of the crossbills than myself. I have now resided for many years in the forests of Sweden—the hot-bed of these birds—and I have paid much attention to the study. I have found it, however, extremely difficult to obtain *certain* proofs of what I state below, although my conclusions are drawn from actual observation of hundreds of specimens, in every stage of plumage—many of them shot from the nest (the most valuable of all to a naturalist who is wishing to solve a difficult problem like the present).

It is only at certain intervals of perhaps two or three years that we have the crossbills breeding in our forests. It is only

when there is a good show of cones on the pine and fir trees that they come to us in any quantities, and when there is no fruit upon these trees we have no crossbills breeding with us. It is also strange that we never on the same year have both the parrot and common crossbill breeding together. In the spring of 1862 we did not take a nest of either bird in our district. In the spring of 1863 I took about thirty nests of the common bird, but only one of the parrot crossbill. In the spring of 1864, I did not obtain a nest of either, and this autumn (October, 1864), I observed the parrot crossbills coming down in small flocks (but I saw no common crossbills), and as they invariably stay over the winter, and breed with us when they come in the autumn, I expect to obtain the nests of the parrot crossbill next March, or even February, but not those of the common bird. Another curious fact is this, that whenever I see large flocks of crossbills in our forests late in autumn, so certain am I that we shall have an open winter, without much snow.

I obtained most of my specimens, and made my observations, chiefly in the very early spring of 1863, when the birds literally swarmed in our forests; and as such an opportunity might not occur again for years, I gave orders to my collectors to begin shooting them in November, when I was certain that the autumnal moult would be complete, and up to the end of January, when they began breeding, I had about a dozen specimens regularly brought in to me every week. From first to last above 150 specimens of male birds passed through my hands, and from the examination of these I draw my conclusions. As I was much interested in the subject, I consulted all the authorities I had at hand to see if I could find any good description of the change of plumage in these birds. Willoughby, Albin, Temminck, Linnæus, Pennant, Montague, Jennyns, Shaw, Thompson, Wood, Morris, Wilson, Nilsson, and Kjärbölling, all lie open upon my table, and hardly two of them seem to agree, or even to afford us any certain clue as to when this change of plumage, which most of them notice, takes place, or how long the red livery is worn, or at what age it is assumed.

A subject, therefore, on which scarcely two naturalists seem agreed, must be an interesting one to investigate.

Willoughby, who wrote in 1668, is quaint, and his style, as is usual with the older authors, "eats short." He has evidently got hold of a female bird, which he describes, and adds: "This bird was described in autumn. He that sold it to us told us that it changed colours thrice in the year, being green in autumn, yellow in winter, and red in spring." He dwells with much unction on the many spiral convolutions in the intestines, and winds up his description with the following quo-

tation from old Aldrovandus: "One thing also more," sayeth Aldrovandus, "seemeth to me strange and unusual in the crossbill—that in the winter time, when all things shrink with cold, and all other things are mute, she sings, which, whether it be true or no, let those observe among whom such birds are common. It sings, they say, very sweetly." Right, old gentleman! The winter song of the crossbill consists of many very pleasing notes, and is heard most when the birds are breeding in the end of the winter.

Albin, who wrote in 1738, follows suit. His description is evidently taken from Willoughby, and his coloured figure represents a formidable-looking dark brown bird, shaded with blue—such as I never saw. There is, however, no doubt about its being a crossbill, when we look at its monstrous beak.

Linnæus does not help us much. "Body varying in colour, reddish, head scarlet," is all that he says.

Old Pennant observes: "It is an undoubted fact that these birds change their colours, or rather the shades of their colours; that is, the males, which are red, vary at certain seasons to deep red to orange, or a shade of yellow." (Thus inferring that the change of colour is *seasonal,* which I can clearly prove is not the case.) "The females, which be green, alter to different shades of the same colour."

Wilson, the American ornithologist, appears also to favour a *seasonal* change of plumage. This idea I do not for one moment entertain. The colours may be a little brighter in the winter than the summer, but that is all.

Montague's description is short and general. He says the plumage of the male varies from beautiful red to orange colour on the head, neck, breast, back, and rump—according to my ideas, just putting the cart before the horse.

Temminck's general description of the adult male is: "Principal colour green. The male, after the first moult until the age of a year, is brick-dust red. Young of the year, grey brown, tinged with green, with dusky longitudinal streaks. Females, at all ages, differ very little from the young." And he further adds that "the female never assumes the red colour which is peculiar to *the male only after the first moult up to the age of a year.*" Here, in my opinion, he is decidedly wrong.

Shaw also says the male varies from a beautiful red to orange colour, on the head, neck, breast, and rump.

Jennyns gives the adult male as cinereous, tinged deeply with green yellow. Male, *after the first moult,* general colour, brick red; female, and young of the year, the same in plumage.

He as well as Morris describes the nest as lined with feathers, but of all the nests which I have taken I never saw a single feather in more than two, and those were stiff pinion

feathers of apparently a bird of the same species, interlaced with the walling of the nest. In fact, the crossbill is no tender bird, and the nest is built of the strongest and coarsest materials, to defy the inclement weather which prevails at the season in which this strange bird has chosen for nidification. It is strange that Nilsson, the great Swedish authority, when speaking of the breeding habits of the crossbill, should say that they breed at all seasons from December to July, and that the winter nest is domed, the summer nest open. This may seem all very natural, but it is not correct. I never saw a domed nest out of the many scores I have taken, although I often wondered that they should not build a domed nest like the wren and the magpie; for often when the month of March has been more than usually cold and snowy, have I found the young ones lying dead in the nest half-filled with snow. The breeding season depends in a certain degree upon the weather, but they never go to nest later than early in March, and by the end of April we shoot strong flyers in our forests. I have taken the nest as early as the end of February, and I never took one with fresh eggs after the very beginning of April. They certainly do not breed twice in the year, at least not in the same district; for about May they begin to flock and leave the forest in which they breed, and during the summer we rarely see them. The parrot crossbill goes to nest usually a fortnight later than the common bird. The nest and eggs of both are much alike, thickly and clumsily built of sticks and moss, that of the parrot crossbill being the largest, and the eggs thicker, and in general more highly coloured. The nest and eggs of the crossbill much resemble those of the greenfinch, but larger. Neither species breed in the deep forest, and seldom in a fir. On stony rises, where the small pines stand wide apart, is the place to look for the nest of the crossbill, at least in Sweden. It is a very easy nest to find, for early in the morning the old male sits on a fir top in the vicinity of the nest, and cheers his sitting mate with a loud and by no means unmelodious song. The nest is always placed close into the stem of the tree, and never high from the ground. The full number of eggs is three; I have seen four, but very rarely.

But to return to the plumage.

Unfortunately, I have not Yarrell at hand. Wood, however, in his *Illustrated Natural History*, by Routledge, which, without being a scientific work, is a very pleasing and useful guide to the naturalist, gives some extracts from Yarrell's *British Birds*, in which both the orange and red plumage is well described. "But," as he says, "a red bird is now before me that had completed his moult before the first autumn."

We may infer that, like the rest, Yarrell considered the red to be the plumage assumed on the first year after leaving the nest. Wood's description of the nesting is correct; but in a similar work by Cassell, we find the following strange account: "Makes its nest of moss and lichen, and fastens it to the branches with the resin of the pine, and covers it with this matter." This I never saw.

Morris gives a good general description, and notices that the young males after the first moult "are variously dull red, reddish, yellowish red, greenish yellow, or dull yellow, shaded with red." Save that I have never yet been able to identify a dull red male just after the first moult, I like this description as well as any. He figures a red male (far too dull, however); but he does not tell us when it is supposed that this red dress is assumed, or how long it lasts.

Although living in the land of crossbills, Nilsson does not help us much. He describes the young bird just after leaving the nest, and also during moults. He says that both sexes are alike at this period, and probably they are; but this matters little, as until they have completed the first moult, the colour of the plumage goes for nothing. Young male after moulting (of course he means after the first moult in the autumn, after they have left the nest), "Red on the head, throat, and whole body, darker on the back and shoulders; old male, green or yellow on all parts where the foregoing are red."

Thus it will be seen that he never mentions the orange-red dress at all. He leads us to suppose that the red plumage is assumed on the first autumnal moult after the bird has left the nest; and that the standard adult plumage is, as he describes it, "green or yellow on all parts where the younger bird was red." He does not state here positively how long the red dress is worn, and from this description we should naturally conclude that the green-yellow dress of extreme age (and the reader must not confound this with the orange-red and yellow plumage of what I consider the young birds after their first autumnal moult) is assumed at the end of the second year.

In a note he adds, "The males can breed before they have attained their standard dress. We therefore find red as well as yellow males breeding." That we certainly do; but these yellow males to which he alludes I can prove satisfactorily to be young birds of the *second* year, and before they have obtained their red dress, and not, as he would imply, males that have changed from red to yellow. I certainly once, and only once, did shoot a very old yellow-green parrot crossbill from the nest, and I fancy this was a bird many years old.

He says that, besides the great change which the males

undergo at the true moult (in autumn), they even change very much between the moults; and this is certainly the case.

Wilson, the American ornithologist, describes the American crossbill, which both he and Audubon, however, consider as distinct from the European bird; and, as we might expect, from his being a field and not a chamber naturalist, comes nearer to the mark in his description when he says, "That the young males are during the first season mixed with ash, then bright greenish yellow, intermixed with spots of dusky olive, all of which yellow plumage becomes in the second year of a light red, having the edges of the tail inclining to yellow." He describes the male in perfect plumage as—General colour red lead, brightish on the rump, intermixed with touches of olive.

Sir W. Jardine, in a note to his edition of Wilson, remarks, "Our author is incorrect in stating that the young males, as is usual with other birds, much resemble the female. In fact, the young of all the crossbills, as well as of the pine grosbeak, contrary to the habit of the generality of birds, lose their red colour as they advance in age, instead of gaining an additional brilliancy of plumage. The figure which our author gives as that of an adult male represents a young bird of about one year old, and his supposed female is a remarkably fine adult male." Now I do not agree with Sir W. Jardine. I contend, and I can prove it, that the red standard livery of the male crossbill (at least that which is worn the longest) becomes brighter and deeper with age; and, moreover, that it is not assumed until the second or third autumnal moult. That the old male crossbill will eventually become bright yellow green, if allowed to live long enough, I will allow. I never, however, saw a crossbill, at any age, like the coloured figure in Wilson, to which Sir William refers; and as for his red male, instead of being a bird one year old, I consider it at least two, and more probably three years old.

Now, if the reader will attentively peruse the above descriptions, he will gather the fact, that the male crossbill is subject to a very great variation in plumage—yellow, orange, red, scarlet, and olive-green—but nothing more. He will not be able to form the least idea at what ages these different plumages are assumed; and his inference will most probably be this, that the old male crossbills have no regularly-defined plumage, but that birds of the same age are as likely to be yellow-orange as red, olive as scarlet. But this is far from being the case. The change of plumage is constant and regular as in any other birds; and I think we can prove that the males have four distinct and clearly-defined dresses following each other with the age of the bird.

Although we can hardly yet offer any certain data to prove

exactly at what age these dresses are assumed, I fancy we can form a tolerably good idea; and I will now proceed to state below, clearly and concisely, the four different stages of plumage which the male crossbill undergoes from birth to very old age. I have paid careful attention to this subject, and I write this with more than fifty packed skins lying before me, all shot here between the 1st of November and the 1st of April, in every stage of plumage, intermediate as well as determined. We will now shortly describe them.

The first dress after just leaving the nest, up to the first autumnal moult, has been correctly described as greenish brown, with dark longitudinal streaks down each feather. In this plumage there is very little difference between the male and female. In the nest plumage the beaks are straight, but the mandibles soon begin to cross after leaving the nest; and in the young birds of the year, killed early in November, the beak is nearly as much crooked as in the older ones. Sometimes the point of the under mandible crosses to the right, but oftener to the left.

As soon as the autumnal moult is completed, the females are easily distinguished from the males. The young feathers (striped) are very apparent in both, but all the under parts are tinged in the young males with yellow orange; in the females with bright yellow. The heads and rumps of the males are orange; in the females, the same parts are only slightly tinged with yellow.

In not one single young male, shot during the autumn or winter, have I seen the slightest indication to lead me to suppose that he would become red before the next autumnal moult, if then. It seems, however, very probable that this orange colour gradually becomes redder without a regular moult; but so much do the shades vary that we scarcely see two birds exactly alike. It would be difficult to say how long this plumage lasts, but I am inclined to think for at least one year, perhaps even for two, for early in November, long after the moulting was over, I have killed males of a beautiful orange male colour, which, from their eye and general appearance, could not have been birds of the year—at least there was a marked difference between them and young males which we knew to be birds of the year, killed at the same time, for in these latter half the plumage at least was composed of the dark-spotted young feathers. Still these larger finer-coloured birds might have been early birds born in the previous spring, although I think not. But that they breed in both these dresses I satisfactorily proved in the spring of 1863, when I took many nests, from which I shot orange males, and two of them I was certain were birds born in 1862, be-

cause so much of the dark streaked young plumage was remaining.

The plumage of the two birds which gave such unmistakeable proofs of being birds of the previous year, was greenish yellow-brown, tinged with orange on the rump and head, without the slightest approach to red. The other four, evidently older birds, were orange red; in two of them the colours very bright, and one was fast approaching to the deep red plumage; but still there is a marked difference between the reddest of these orange birds and the lightest coloured of twenty-five pure red birds which now lie before me. It is moreover, to my eye, very easy to trace the gradual change from the light orange yellow—which seems to be the first colour that mixes with the young plumage—to dark orange, and then deep red of the maturer bird. It is, I think, most probable that these fine orange birds were males in their third year, which would have become red had they lived to the next autumn. However this may be, I am pretty certain that anyone who saw my series of birds lying in a row, would agree with me that both these yellow and orange dresses are intermediate between the first plumage and the red dress; and in all the red birds there is little difference in the shading, except that in some the rumps are brighter than in the others; and in one or two a few green feathers may be seen shooting out among the red feathers on the back and head. In the summer the red colour is always dullest.

We now come to the third dress, for I consider this orange dress as nothing more than a transition from the yellow to the red. This is deep red. Brightest on the rump and head, blackish on the back, lightest on the belly—certainly purer and clearer in some birds than others, but pretty much the same in all; and this I consider the true standard livery of the male crossbill, but how long they wear it it is impossible to say —probably for two or three years.

Respecting the fourth, or bright yellow-green dress, which the very old male crossbills occasionally assume, but which, although so very rare that we scarcely see one of these bright yellow-green birds in a hundred, we must still, I think, admit to be normal (and this dress I fancy many naturalists have confounded with the yellow and orange dress of youth); it is very hard to say at what age it is assumed, but as we see so few of them, it is reasonable to suppose that it must be at a very advanced period of life, in a state of nature, although it would appear that so soon as either the crossbill or the pine grosbeak is confined in a cage, they change from red to this bright yellow livery, which they wear till they die. And I have seen an old male grosbeak, which was bright red when

he was caged in the winter, but at the next autumnal moult he changed to bright yellow-green—brightest on the rump and head—and which dress he has worn for ten years. This may, or may not, be the effect of confinement, but as I have killed one old male parrot crossbill in this dress, from his nest in the open forest, I do not hesitate to pronounce it normal. This latter dress is very different from the young yellow or orange dress first noticed.

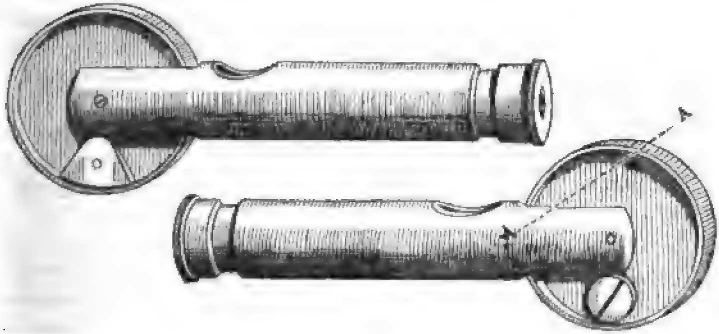
The only change that I can observe in the female crossbills is that the yellow shading on the head and rump appears to become brighter with age, but always brightest in the breeding season.

Of course, much of what I have stated must be from supposition, as it is impossible to obtain certain proofs regarding the change of plumage in this bird, if, as so many naturalists tell us, confinement so totally changes its colour. No one can positively say that these orange birds are what I suppose them to be—birds of the second or third year; but the young yellow birds which I shot from the nest, with more than half the dark young feathers remaining, clearly proved, at least to me, that the first plumage in the young male, after the spotted dress of youth, is not red, as has been erroneously stated, but yellow green; and the gradual change from yellow to orange, and from orange to deep red, is so marked in many of my specimens, that I have not the slightest doubt in my mind that the changes of plumage are as I have stated above. Still it is a subject I approach with diffidence, as it is one which has puzzled so many better naturalists than myself. However, in a case like the present, a man can but lay facts before his readers, and leave them to draw their own conclusions; and even if he is wrong there is no harm in his stating what conclusions he draws himself. The subject is a most interesting one, and I do not believe any naturalist has taken more pains to arrive at the truth than myself.

I must, before concluding, notice a rather singular fact, that in not one of all the birds I mention as being killed between October and April, did I observe a single blood feather, either yellow, orange, or red, as in the grosbeaks, which I shot in deep moult in August, or in the ptarmigan, which show blood feathers at every change of plumage. It proves, I fancy, that the moult was long over before I began to collect my specimens, and I fancy it goes also far to prove that a great part of the change takes place between the true moults by an actual change of colour.

A NEW ANGLE MEASURER.

BY THE REV. N. J. HEINEKEN.



THIS instrument, which I have lately contrived, is on the principle of Schmalcalder's quadrant, but of dimensions small enough for the waistcoat pocket. In the Schmalcalder, moreover, a prism is used for reading off the angle at the same time that the object is viewed. In mine, the divisions are read off by a lens, and a needle point, passing through the side of the tube, and close to the divided wheel, forms the index. The object is seen with the *other* eye at the *same time;* the instrument being elevated or depressed, till the needle point appears to be in contact with the object as well as with the division of the circle. The angle of altitude is thus indicated. The drawings are of full size. I add a description and measurements of the instrument. A flanged wheel $1\frac{1}{10}$ inch diameter, has one half and a little more divided into degrees, the surplus being for index error; edge of wheel $\frac{2}{10}$ wide; flange on each side about $\frac{7}{100}$ deep. Within this flange on one side is a large-headed screw of brass, and on the opposite side a triangular piece of copper to which it is attached. The screw passes through a slotted hole in the wheel. The screw and piece of copper form a counterpoise to the wheel, and the slot allows of adjustment of the Zero point.

A brass tube $2\frac{2}{10}$ long and $\frac{4}{10}$ diameter is filed out at one end so as to admit the above wheel, which is suspended as *delicately as possible* by a fine pointed screw on each side, the points of which screws enter a very fine hole, drilled in the axis of the wheel; upon the nicety of this suspension the accuracy of the instrument depends.

An aperture is made in the tube, near the wheel, to admit light for reading off the divisions, and moreover at this part the interior of the tube is silvered.

At A, a needle point passes through the side of the tube to furnish an index, as before stated.

The other end of the tube carries a lens of $1\frac{7}{10}$ focus, for viewing the needle point and divisions of the wheel. Some time since I gave Mr. Elliott, optician of the Strand, permission to make similar instruments if he wished to do so. He may possibly have some in stock, but of this I am not informed.

For measuring a short base line I use, with the angular instrument, a light rod of deal, 5 feet in length and $\frac{3}{4}$ inch square. This is attached by a joint at the centre to a walking stick.* A short base line is readily measured by this—merely marking by a scratch on the ground each length of 5 feet as you proceed. To register the number of lengths, I have a small toothed wheel, $2\frac{1}{2}$ inches in diameter, which is attached to a foundation plate by a screw in its centre. A spring catch enters the teeth. Thus, by moving a tooth for each ten or other lengths of the measuring rod, an accurate account is kept. Instead of the toothed wheel an account may be kept by shifting a number of marbles from one pocket to the other.

We hope the following hint may also be of service. Having made one of the reflecting levels (a very useful pocket-companion) described in Heather's *Treatise on Mathematical Instruments*, p. 120 (Weale), I had difficulty in making the line scratched on the mirror perfectly horizontal. This difficulty may be obviated by adopting a circular instead of a square shape for the centre of the instrument. In this a cell for the mirror may be turned, and it can then be adjusted with the greatest accuracy.

[We think Mr. Heineken's ingenious instrument might be improved by enabling *one* eye to view the object and read off the altitude on the scale. If the wheel and its supports occupied half the tube, and a knife edge or needle were stretched right across it, the eye, *looking through a hole* drilled in the centre of the lens at the eye-piece, would see the object, and be able to bring up the instrument so that it coincided with the knife edge, and the same eye looking through the lens would read off the magnified image of the scale. In this modification it would be better to have the tube square, as the wheel might then come very close to one side. Mr. Heineken finds that the error introduced by looking through the instrument with one eye, and at the object with the other, is very small, but we think, with most observers, it would be less with the modification suggested.]

* Mr. Heineken has sent us a drawing of this contrivance. The walking stick and the measuring rod, when not in use, fold together; when in use they open like an inverted capital T (⊥), and by holding the walking stick in the hand, and pressing the rod to the ground, the measure can be taken without stooping.

PROFESSOR HAUGHTON'S GEOLOGY.

A LITTLE while ago we had to speak very highly of a publication belonging to "Galbraith and Houghton's Scientific Manuals" — we mean Dr. Apjohn's *Manual of the Metalloids*—and our reason for commending that useful work was, that it formed a good introduction to chemical philosophy, as well as offered to students a compendious collection of well-assorted facts. In all sciences it is easy to discriminate between its philosophy and the real or supposed facts which form its basis, and out of which the philosophy must be evolved. Facts alone, however carefully collected and verified, do not constitute a science; they are only the bricks or stones with which the edifice must be built: and it is of more importance to acquire a sound method of reasoning, than simply to accumulate a large store of particulars, which must remain in the condition of the dry bones of knowledge until a philosophic informing spirit gives them organic relation and life. The more complex the science, the greater need of breadth and clearness of philosophical conception, and the greater need also to cultivate such a habit of prudent doubt, that while certain theories may be employed on the ground of their apparent probability, they may be held so lightly as to be discarded the moment a better theory can be obtained. Geology, as a science of remarkable complexity, stretching its roots on all sides, and making them ramify in all directions, from physics to biology, cannot be decently taught without a careful philosophy to accompany the learner at every step. In no one department does geology—as at present known—present its votaries with a complete cycle of facts. The physics of the globe are yet sadly incomplete, and our information is exceedingly small concerning the condition of the inner portions of our planet. The chemistry of geology is likewise in its infancy, and few questions of importance respecting the chemical formation of rocks have been fairly solved. Equally incomplete is the biology of geology. As former articles in this work have shown, the stone record is exceedingly imperfect, and thus we have nothing approaching to a complete collection of the remains of the organized beings that occupied the globe at any given time, and the physiologist cannot supply us with biological laws of sufficient generality to justify a wide deductive reasoning capable of explaining the fragmentary groups of facts that we possess.

Another peculiarity of geology is its rapid growth, by which hypotheses are continually superannuated, and doctrines highly cherished to-day placed in such fresh lights that they

must be abandoned to-morrow by the sincere searcher after truth. Such a condition of science is, no doubt, awkward for a professor, because, if he is competent to his task, and performs it conscientiously, he must, at almost every step, warn his pupils against putting implicit faith in the opinions he may express. A good set of lectures on geology, or a good book on the subject, should not only explain the latest important facts and modifications of theory, but prepare the student for the reception of fresh facts that may militate against opinions that appear fairly established upon satisfactory grounds. The history of science is that of a series of surprises. A few great men may usually have had glimpses, or intimations, of forthcoming truth; but the general tendency of discovery is to startle the mind with unexpected verities, that wage vigorous warfare against existing ideas.

A good manual of geology would have been a real boon to the student public, because, notwithstanding the great merit of existing works, and especially those of Sir C. Lyell, it would be impossible to name a single volume in which the present aspects of the science are compendiously displayed. That the Rev. Samuel Haughton* has not succeeded in supplying this want, partly arises from some personal peculiarities, and partly from the obvious fact that in the work before us he has not done justice to his own powers. The course of lectures out of which his *Manual of Geology* has been compiled could scarcely have been prepared with express view of the use now made of it, and thus there is much to object to in the plan of the work. Its chief fault, however, is its remarkable omission of important facts, of recent date in the order of their discovery, and an equally remarkable omission of philosophical doubt and prudent caution in dealing with the theoretical parts of the subject.

Like Diedrick Knickerbocker, in his never to be forgotten *History of New York from the beginning of the World to the end of the Dutch Dynasty,* Mr. Haughton commences with a cosmogony. He accepts as probable, and in accordance with the views of most scientific men, the "nebular hypothesis," and he conceives our globe to have slowly cooled down, from the condition of a widely-diffused gaseous body to that of a compact little world. To this we have nothing to object; but he treats certain theories of M. Durocher, to which grave objections might be made, as if the suppositions of that ingenious gentleman were to be accepted as verified facts. M. Durocher, with that desire to present a neat round mode of accounting

* *Manual of Geology.* By the Rev. Samuel Haughton, M.D., F.R.S., Fellow of Trinity College, and Professor of Geology in the University of Dublin. Longmans.

for everything, which often charms his rapidly generalizing countrymen, tells us, according to Mr. Haughton's translation, "that the first and second layers of the globe are composed of totally different materials. The outer layer, which he calls the Acid Magma, corresponds with the granites; and the inner, or second layer, which he calls the Basic Magma, corresponds with the trap rocks and greenstones." If the various components of granites are lumped together, it appears that they contain about 71 per cent. of silica, while the rocks belonging to the so-called Basic Magma series contain about 51 per cent.; the quantity of oxygen in the two cases is represented by the figures 48·22 and 43·60 respectively. We do not deny that M. Durocher has something to say in favour of his supposition, that under the hardened crust of the globe are his two *fluid magmas;* but it seems to us rash in Professor Haughton to exclaim, "we adopt then, as chemical geologists, Durocher's hypothesis as to the first and second layers of the globe." M. Durocher writes on the proceedings of his magmas with all the confidence of an eye-witness who was comfortably situated so as to watch the condensation of nebulous matter, and its assumption of terrestrial form. He says, according to Mr. Haughton's translation of his paper, "the first pellicle that solidified on the surface of the yet incandescent globe was evidently formed by the uppermost layer, the lightest and the most fusible; thence resulted the primitive granite." How do we know anything about the *first pellicle* of our globe? Who has an authentic bit of it, and where is it to be found? In his text, Professor Haughton appears to tell us where to find it; but in a more cautious appendix he leaves us quite at sea. The text of the *Manual* says, "as the globe cooled, we know that fissures formed in it, evidence of which fissures still remains in our mountain chains and metallic lodes."

Now is there a particle of proof that the fissures in the terrestrial surface which now appear, were made in the earliest days of the earth's existence as a solidifying planet? Professor Haughton apparently saw the doubt that must arise in most minds against M. Durocher's assumptions, and accordingly in Appendix B he says, that although he has adopted in the text Durocher's theory of the granitic and trappean magmas, yet he does not believe that "any trace of these primitive magmas can be found." But if no trace exists of the first portion of solidified magma, how can the *fissures* thereof remain unto this day? We can understand a cracked plate; but we should be surprised to see the "fissures" after all trace of the plate had disappeared. It is evident that in this case Professor Haughton shows to better advantage in his appendix than in his text, and if he had gone a little further, suppressed

the text, and made the work *all appendix*, we have no doubt he would have done greater justice to his acquirements and powers. We have proof of this when we compare the remarks on geological time made in the fourth lecture with the opposite remarks which the appendix affords.

In the text, Professor W. Thompson's allowance of time, based upon calculations as to how long the sun may have been shining upon our earth, if certain assumed conditions are correct, is stated to be "very liberal," and geologists are soundly rated for not being contented with one, or even five hundred millions of years; while in the appendix we find Professor Haughton making an elaborate computation according to a formula of Helmholz—who thought to solve the difficulty by inquiring how long it would take for the earth to cool down from an incandescent state to a temperature at which any organic being we are acquainted with could live—and finding that 1280 millions of years would elapse as the time of cooling from 122° to 77°. Commenting on these figures, the Professor says, "Vast as the period of 1280 millions of years must appear to us, yet the globe was habitable, in parts at least, for a longer period, for the polar temperature would have admitted of the existence of animal life before it was possible in Britain, and it is also highly probable that the rate of cooling of the earth was slower than is here assumed."

If we pass from this part of the subject to the zoology and palæontology of Mr. Haughton's manual, we find ourselves unable to applaud the text, and without the consolation of finding it handsomely contradicted in the appendix.

In speaking of the Foraminifers, Professor Haughton proceeds as if Carpenter, Jones, and Parker had not commenced their well-known labours, and he accordingly follows a method of division in which the arrangement of the cells, whether rectilinear, spiral, or irregular, is made the basis of classification. Much information on this subject will be found in the admirable paper from the pen of Dr. Carpenter, which we published in our vol. vii., p. 278;* and we may cite a passage from the last edition of his work on the microscope, in which he states that, "plan of growth is a character of very subordinate importance among the foraminifera, and that any classification which is primarily based upon it must necessarily be altogether unnatural."

Professor Haughton gives a representation of the *Pterygotus acuminatus*, or as it is now called *Slimonia acuminata*, and it is a pity that in this case he did not refer to the specimens obtained more than two years ago by the British Museum, from

* "On the Structure, Affinities, and Geological Position of the Eozoon Canadense."

which Mr. H. Woodward made an excellent drawing, which we published in November, 1863.

A student not duly cautioned against the deficiencies of Professor Haughton's book would be grievously misled by his remarks on the total thicknesses of different strata, and the periods of geological time which they represent. He takes what he calls "Azoic rocks," in which he seems to include the formation containing the *Eozoon Canadense,* to be 4·333 geographical miles thick, the Lower Palæozoic 5·082, the Upper Palæozoic 4·458, and the Neozoic 4·512; and as these figures approximately coincide, he says, "It is therefore exceedingly probable that these four great periods of the earth's history are of nearly equal value in point of duration." In this calculation no notice is taken of the breaks in the succession of the various strata, and the consequent gaps in the records which the geologist has to decipher. If we knew from physical reasons, that at a given number of millions of years ago every portion of our globe was too hot for the existence of any organized creatures analogous to those now living upon it, we should be justified in stating that previous to that time all formations would belong to the lifeless or Azoic age; but notwithstanding the repeated proof of the vanity of arriving at this class of positive decision upon merely negative evidence, Professor Haughton endeavours to fix in the minds of his pupils a philosophy which is obviously unsound. It happens, and may happen to an extent far greater than is yet known, that leaves and chapters of the Stone Book, wanting in some editions, may be supplied in others—that is to say, for example, that strata omitted in England are or may be detected elsewhere; but there is little hope that a complete series will be made out, and as the matter at present stands, the gaps are of immense importance when we have to consider either the time spaces represented by groups of formations, or the changes that have been experienced by the organic life of the globe.* Professor Huxley has shown that it is common to make a great exaggeration in speaking of the differences that are traceable when existing plants and animals are compared with those of past geological epochs. He says,† "We are all accustomed to speak of the number and extent of the changes in the living population of the globe during geological time, as something enormous; and indeed they are so, if we regard only the negative differences which separate the older rocks from the more modern, and if we look upon specific and generic changes as great changes, which from one point of view they truly are. But leaving the negative differences out of con-

* See "Missing Chapters of Geological History," in our vol. vi., p. 12.

† *Quarterly Journal Geological Society*, May, 1862, p. xlviii.

sideration, and looking only at the positive data furnished by the fossil world from a broader point of view—from that of the comparative anatomist who has made the study of the greater modifications of the animal form his chief business—a surprise of another kind dawns upon his mind; and under this aspect the *smallness* of the total change becomes as astonishing as was its greatness under the other." Professor Huxley then points out, that no new *ordinal* type of vegetable structure has been discovered in a fossil state, and that "no fossil animal is so distinct from those now living as to be arranged even in a separate class from those which contain existing forms."

A philosophy of geology which takes no notice of this class of fact is deplorably incomplete. It is of the utmost importance, when speculating upon the discordance between the organic life of one period and that of another, to consider all evidence, whether negative or positive, that indicates the probability of the change having been of a slow and gradual kind. Professor Haughton does not feel this. He considers that the modifications of the globe from the nebulous to the solid form, and thence through various changes brought about by physical and chemical agencies, to the condition in which we find it, have resulted from the operation of natural laws; but he refers all changes in organic life to the "*arbitrary* will of the Creator," by which we presume he means a kind of will distinct from that which is manifested in the operations of unorganized matter, in which law and intelligible order prevail. This is a most unfortunate attempt to place a theological barrier in the way of scientific inquiry. It practically tells man that he may profitably endeavour to trace the *physical* changes of the globe; in them he will see the operations of a will acting upon methods he may hope to some extent to understand; but that the moment he comes to the simplest living creature, he is in contact with another kind of will, which being "arbitrary," cannot possibly be understood. Real science makes no such distinctions. It perceives no traces of will without reason, and when it finds itself baffled by the complexity of phenomena, it does not conceive that there is anything in them more "arbitrary" than in the more obvious sequences of cause and effect.

We have cited Huxley on the question of life-changes on the globe, and we dismiss this part of the subject by a parallel quotation from Ramsay, who says, in reference to the relative position of strata and the distribution of life, "I cannot resist the general inference that in cases of superposition, in proportion as the species are more or less continuous, that is to say, as the break in life is partial or complete, first in the species,

but more importantly in the loss of old and the appearance of new or unallied genera, so was the interval of time, shorter or longer, that elapsed between the close of the lower and the commencement of the upper formation; and so it often happens that strata a few yards in thickness, or, more notably still, *the absence of these strata,* may serve to indicate a period of time as great as the vast accumulation of the whole Silurian series."

Professor Haughton is decidedly reckless in the assertion that whenever a creature deviates from the original type, the result is a "monstrosity," and an imperfection, and "not an advantage." If Mr. Haughton selected any kind of dog as his original type, how could he demonstrate anything of the kind? He might show that particular breeds of dogs were only capable of preservation under conditions of considerable care and attention; but it would not be true that spaniels, or terriers, or hounds ought to be regarded as "monstrosities," exhibiting "imperfections" and disadvantages just so far as they differed from his original type. The pigeon fancier might point to hardy and delicate varieties; but could he not find two or more varieties, differing considerably from each other, and differing from the supposed primitive type, and yet healthy and strong? We do not believe that *all* departures from particular types involve imperfection. That some deviations are altogether mischievous we do not deny, and others serve a particular purpose at a special expense of injury in another direction. Our gardeners have however supplied us with abundance of healthy varieties of plants, and our breeders have assuredly produced healthy varieties of stock.

We are sorry that we cannot speak more favourably of Mr. Haughton's *Manual of Geology.* In many matters of detail his acquaintance with specialities may show to advantage; but on the whole the book is a failure, the more unfortunate from the position and reputation of its author.

DAVAINE ON VINEGAR EELS.

M. Davaine has a paper on the Vinegar Eel, *Anguillula aceti*, as it is usually called by microscopists, or *Rhabditis aceti* of Dujardin, in *Comptes Rendus*, No. 6, 1865, in which he states, "Acidity is not a condition necessary to the existence of the vinegar eels. Mineral acids, oxalic, acetic, and citric acids, diluted with pure water to the degree of the vinegar in which the eels live, cause them to perish in a few hours or in a few days; on the other hand they live and propagate rapidly in a non-acid liquid if it contains sugar. In pure water the Anguillula perishes in about a week; but will live for several weeks if one or two thousandth parts of sugar is added, and several months if three to five thousandth parts are introduced. In water containing five per cent. of sugar they perpetuate themselves and multiply in great numbers. Their multiplication seems to stand in relation to the quantity of sugar; it augments notably up to 30 per cent.; at 40 per cent. it remains stationary; while in water containing 50 per cent. they no longer increase but perish.

"In a few days the sugar-water becomes sour through the formation of lactic acid; but this acidity may be neutralized by placing in the vessel a thick layer of powdered chalk. The Anguillulæ then multiply to a greater extent than in an acid liquid.

"Guided by these results," says M. Davaine, "I placed some Anguillulæ in fruits that were neutral or slightly acid, such as peaches, prunes, apricots, grapes, cherries, gooseberries, apples, pears, melons, etc., and in every case they multiplied prodigiously; their fecundity being in relation to the quantity of sugar present, beetroot and onions standing in the first rank, then carrots and tomatoes, and lastly turnips.

"The Anguillulæ grown in these different materials did not experience any modification, and in flour paste, where they have ample nourishment and increase prodigiously, they do not differ in length, thickness, or aspect.

"These facts appear to indicate clearly the native country of the vinegar eel; it lives and multiplies by the million in fruits which fall to the ground, and in the saccharine roots growing in the soil. To enable them to seek this food they are endowed with a well-developed faculty of locomotion, and they can live more than three weeks in moist earth without any other nourishment."

M. Davaine adds that these Anguillulæ live exclusively in vinegar obtained from fruit.

CLUSTERS AND NEBULÆ.—DOUBLE STARS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

THE rapidly-shortening days, however we may regret the loss of out-door pleasures, bring their compensation to the astronomical student in the increased opportunities of searching for nebulæ, and discovering the footsteps of the Creator's glory in his more distant and, at any rate, less conspicuous works. To these, therefore, we shall now re-conduct our readers, enlarging, at the same time, our list of Double Stars, which has long remained in a stationary condition.

We begin with an object so intrinsically marvellous, that we can but regret that so few amateurs are likely to be in possession of the means of developing its structure. As in many other cases, however, it will be interesting merely to look *at* that which more fortunate observers are permitted to look *into*. They, too, in turn, will have their own regret that they are unable to look *through* a wonder, the true nature of which is, notwithstanding, in all probability inaccessible to mortal gaze. This is

29. *The Great Spiral Nebula in Canes Venatici.* 51 M. To find this, we must first get the bright star at the tip of the Great Bear's tail, *η Ursæ Majoris*, alias *Al Kaid* (sometimes called *Benetnasch*). Nearly 2° (of arc, not of R.A., which makes a material difference in these circumpolar regions) *p* this, lies a 5-mag. star, 24 in *Canes Venatici*, or simply 24 *Canum*, the plural form sufficiently indicating that it does not belong to either *Canis Major* or *Minor*. *sp* this, we shall notice an open triangle of much smaller stars, and just *p* the star at the S. angle (or 2° *s*, a little *p*, from 24 *Canum*), a finder of 1¼-inch aperture will show a dull and feebly visible patch. Powers of 30 and 65 upon 5½ inches show a double nebula in contact, the larger one about four times the size of the smaller; each possessing a sharp nucleus of nearly equal intensity. With steady gazing, the larger nebulosity shows some feeble traces of convolutions or indistinct irregularities. A power of only 111 proved already too high for its faint and misty light. Messier, the discoverer in 1772, failed, as might be expected, in doing more than perceiving the duplicity and contact, and measuring the central distance. ♅ first perceived that one of the nuclei was surrounded by a distant halo or glory, which, in fact, forms the exterior edge of the larger nebula, as seen in ordinary telescopes. His son detected and drew a "partial subdivision of this ring into two branches throughout its *sf* limb," and thought it might resemble our

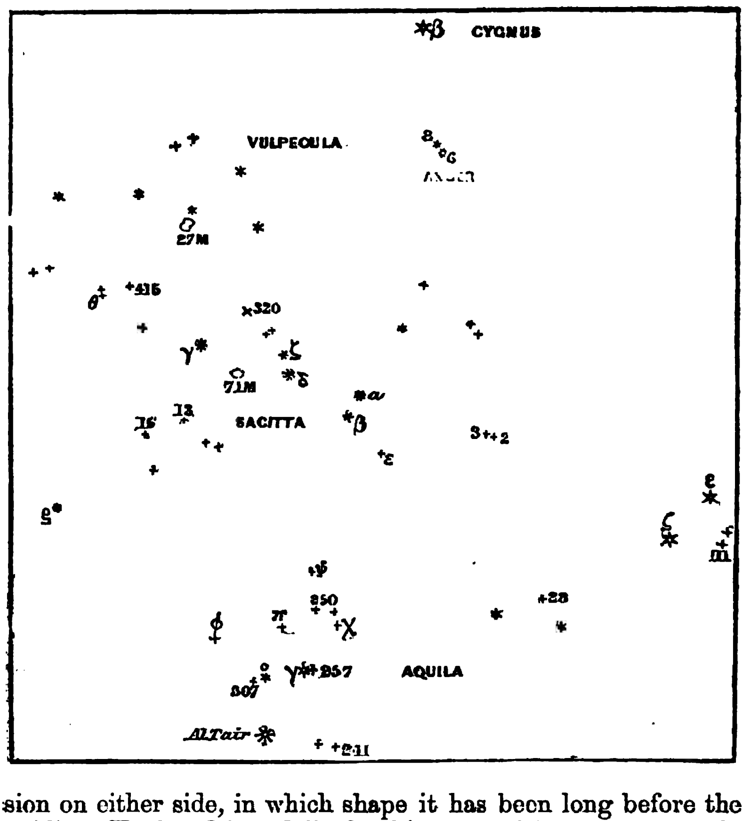
similarly divided galaxy in its construction. "Can it then be," he asks, "that we have here a brother-system bearing a real physical resemblance and strong analogy of structure to our own?" But what an astonishing disclosure of a spiral convolution has here been made by the 6-foot mirror of the Earl of Rosse is now so well known through the multiplication of representations (not all of them, it may be feared, much like the original!), that it need not be enlarged upon here. Our readers will, however, be glad to be made acquainted with that great observer's comments. After having remarked that Herschel II.'s figure of the partially split ring, taken with a "front-view," and therefore reversed right and left only, requires to be inverted also before it will correspond with the Newtonian image of his reflector, he proceeds, "We thus observe that with each successive increase of optical power the structure has become more complicated and more unlike anything which we could picture to ourselves as the result of any form of dynamical law of which we find a counterpart in our system. The connection of the companion with the greater nebula, of which there is not the least doubt, and in the way represented in the sketch, adds, as it appears to me, if possible, to the difficulty of forming any conceivable hypothesis. That such a system should exist, without internal movement, seems to be in the highest degree improbable: we may possibly aid our conceptions by coupling with the idea of motion that of a resisting medium; but we cannot regard such a system in any way as a case of mere statical equilibrium. Measurements, therefore, are of the highest interest, but, unfortunately, they are attended with great difficulties. Measurements of the points of maximum brightness in the mottling of the different convolutions must necessarily be very loose; for although on the finest nights we see them breaking up into stars, the exceedingly minute stars cannot be seen steadily, and to identify one in each case would be impossible with our present means." The central nucleus he saw clearly resolved with his smaller speculum of 3 feet in diameter, and the 6-feet showed the spirality of the principal nucleus very plain, and a spiral arrangement in the smaller nucleus, and he thought that considerably less power would suffice on a very fine night to bring out the principal convolutions. Accordingly this impression has been verified by Secchi, who with 9½ inches of aperture in the Roman sky was able to attest the great accuracy of the Earl's representation. He succeeded in tracing very fairly the two branches of the spiral, and in detecting many stars; but whether in, or only in front of, the nebulosity, he leaves undecided. He has noticed it as a peculiarity that it will not bear magnifying power. His mea-

sures give, for 1855·448, position 15°·54; distance 4′ 22″·78. This wonderful object, which stands as No. 1622 in H.'s catalogue of 1833, and 3572 in the General Catalogue, is the leader of the marvellous class of *spiral nebulæ* of which the Earl of Rosse had, up to 1850, discovered 14, with suspicions of others, and concerning which he remarks, that "the question may perhaps suggest itself, whether there is not something in the aspect of a spiral nebula which forces upon us the conviction that it is a system with an organization quite different from that of any known cluster. The only answer I am enabled to give to that question is, that in the exterior stars of some clusters there appears to be a tendency to an arrangement in curved branches, which cannot well be unreal or accidental;" and he instances 5, 10, and 13 M.; in the latter of which H. had already noticed this structure. It has also been remarked by Secchi among the stars of the galaxy, and was traced by G. P. Bond among the wisps and streaks of the nebula in Orion—a singular fact in connection with the gaseous composition now ascribed to it by the best observers of the day. We have as yet no intelligence as regards the result of Mr. Huggins's examination of the Great Spiral; and it may be feared that the light is too feeble for satisfactory analysis. With regard to the starry appearance, which seems to have been more visible to Secchi than might have been expected from Lord Rosse's remarks, we may observe that the former thinks that his achromatic has more resolving power than the latter's reflectors, owing to its superb definition. It may possibly be worthy of notice that, in the catalogue of 1833, H. has spoken of the companion nebula as "very suddenly brightening in the middle to a star," a description which does not appear in the accounts of other astronomers.

We proceed now to another celebrated object—

30. *The Dumb-Bell Nebula in Vulpecula.* 27 M. 2060 H. 4532 Gen. Cat. It would be difficult to find this object from description, and a diagram is therefore given, including the portion of the sky between *Albireo* (*β Cygni*) and *Al Tair* (*α Aquilæ*), by means of which, with a good eye and ordinary finder, it may be picked up without much trouble; especially after the student has carefully noted the four leading stars of the little constellation *Sagitta α, β, δ, γ*; about 3° N. of the latter, inclining a very little to the E., a keen sight will catch a 5-mag. star, 14 *Vulpeculæ*, just *sf* which the nebula will be detected, though not readily, with a finder of 1¼ inch aperture. With 5½ inches and a power of 65 it is a comparatively brilliant mass of luminous haze, divided into two contiguous oval lobes, on either side attended with much irregular scattered light, involving a 10-mag. star, *p* the S. end. H, who seems to have

noticed only the more luminous part, described it as of a mottled aspect. H. filled up the notches with feebler nebulosity projecting on either side so as to complete an ellipse, or possibly an elliptical ring, at right angles to the direction of the two bright lobes. The longest diameter he found 7′ or 8′. He considered it not resolvable, but perceived in it four stars of 12, 12—13, 13, and 14—15 mags. The S. head was a very little the denser of the two. The Earl of Rosse's 3-foot mirror somewhat varied this form, by giving to one lobe a wide exten-



sion on either side, in which shape it has been long before the public. He found it a difficult object, requiring an extremely fine night and tolerably high power, when it was "seen to consist of innumerable stars, mixed with nebulosity." The 6-foot speculum again changed its aspect, showing a greater variety of details, and especially a narrow detached stripe of faint light bordering much of the circumference, and extending one end of the oval into a point, so as to give the whole a rude resemblance to a widely-opened eye. The resolvability does

not, however, seem to have been increased. In the autumns of 1850 and 1851 the positions of twenty-one stars were measured by his lordship's assistant, Mr. Bindon Stoney, and very many more were distinctly seen, but not inserted in his sketch. The powers employed were low, the number of stars visible depending, he says, even more upon magnifying power and distinctness than aperture. Several of those in his diagram lie, as might be expected, much outside the extent of the nebula in smaller instruments. O. Struve had previously measured twenty-five stars with a power of 207 in the great Poulkowa refractor, possibly not exactly within the same limits. Six of those fixed by Mr. Stoney are not found in Struve's list. Excepting one of 8 mag. (= 8¾ Sm.) the rest as given by Struve range from 10—11 (about 12 to 14 Sm.) to 13 mag. (= 20 or less); one only reaching 10—11, and two others 11 (=15). Two or three of these I was enabled to pick out with an 8-inch silvered glass speculum, by Mr. With. They are admirable tests for the light and definition of a superior telescope.

Secchi, whose design is in some sense intermediate between the two of Lord Rosse, and contains nearly as many stars, sees a few of them steadily, but the rest by glimpses only, and it is not surprising, therefore, that many of their positions are different. Besides these, he sees the bright lobes and their uniting isthmus all dotted, and believes their composition to be stellar. We have every reason, however, to suppose that all the recognized starry points belong to the dense myriads of the galaxy, since Mr. Huggins's analysis, instead of exhibiting the continuous spectrum which would have resulted from an aggregation of stars, brought out, from different parts of the nebula alike, but one single bright line, which "was ascertained, by a simultaneous comparison with the spectrum of the [electrical] induction spark, to agree in position with the brightest of the lines of nitrogen." So that this gaseous wonder—for all that can be proved to the contrary—may actually lie far on this side those glimmering points, and at a comparatively small distance from our own system. On this account, as changes might possibly be detected in it, Secchi's measures become of value. He gives, for the lesser diameter, 1′ 44″·44; for its position 6°; for that of the longer axis 97°. H. had found, about twenty years previously, 31°·4 and 117°·1 for these respective angles; but with a form so unmeasurable, and observed with such different instruments, it is obvious that nothing could be inferred excepting from a much wider discordance.

Our next will be a much more intelligible, though less interesting object—

31. 71 M. (*Sagittæ*). This will be found with little trouble from γ and δ, as shown in the diagram. If we start from γ, an

orange 4-mag. star, we shall find, something less than 2° *p*, a little *s*, a number of small stars, forming a very fine group in a large field; just *f* this, we catch a faint cloud, which readily yields up its stellar components to increasing power. It is 4520 of Gen. Cat., 2056 H. (1833), who says it fills his field (15′), but occupies 3′ with its most condensed part, which is of an acute triangular form; the stars ranging from 11 to 16 mags.

DOUBLE STARS.

The little map which has served as a guide to the two preceding objects will also aid us materially in discovering a number of pairs, which would otherwise, from their minuteness or their position, have been omitted from our list. In order to keep the diagram more clear, no *numbers* are affixed, excepting to the stars which we are about to examine, and those referring to Piazzi's catalogue are abbreviated by the omission of his initial and hour. Beginning from the N., where *Albireo* (*β Cygni*) is conspicuous, we come first to—

135. 6 and 8 *Anseris*, a noble wide 4 and 5 mag. pair, not in Sm.; both orange; the larger a very fine colour. There are three other little pairs, and many small stars, included in a very beautiful low-power field. Next we take—

136. *θ Sagittæ*, a triple group. 11″·4 and 70″·1. 327°·1 and 226°·6. 7, 8, and 9. Pale topaz, grey, and pearly yellow. This very pretty combination, which lies in a fine field, is readily found by carrying a line from δ through γ as far again. Nearly 1° *np θ*, but much more *p* than *n*, being the first star in that direction in the finder, where it is just visible, we come upon—

137. 415 P. XIX. *Vulpeculæ*. 4″·5. 340°·5. 8 and 10. Pale white and sky blue (1838·7). This pretty pair is in "a fine galaxy splash of stars." The larger star, or in observatory language A, appeared reddish to me, 1864·8. Both components are visible with 65, but it is very minute and delicate. Sm. considers it stationary, but Secchi thinks it may be in motion.

Reverting to γ *Sagittæ*, we shall perceive in the finder about 2° *np*, a little triangle of 7-mag. stars, of which the two lying *p*, 299 and 301 P. XIX, are comparatively near together; the hindmost is double, being—

138. 320 P. XIX. *Vulpeculæ*. 42″·7. 147°·6. Both 7. White. This is a peculiarly beautiful open pair, probably stationary. In the same field, *p* a little *s*, I noticed a pretty group, consisting of a smaller, closer, and more unequal pair, followed by a very minute star nearly in the same line.

δ *Sagittæ*, 4 mag., is worth looking at for its fine orange-

yellow colour—a hue which in a minor degree predominates in this region, being noticeable in α, β, γ, and η of this constellation,* besides others which come before us as pairs. δ is also beautifully situated in a rich galaxy region full of glorious combinations of minute stars. But we are now about to use it as a pointer to the next object, lying a little way *nf*—

139. ζ *Sagittæ.* 8″·6. 312°·3. 5 and 9. Silvery or flushed white and cerulean blue; improving greatly under red illumination. A pretty double star.

13 and 15 *Sagittæ* (not in Sm.) will both repay the finding, as the centres of fine groups, especially the former, in which the *lucida* is of a fine orange, while a smaller one is very red.

140. ϵ *Sagittæ.* 1′ 32″·2. 80°·9. 6 and 8. Faint yellow and bluish. This wide but pleasing object may be found by means of α and β.

141. 2 and 3 *Sagittæ* (not in Sm.) These two 6-mag. stars, of which 2 is considerably the larger, form a fine wide pair. Both are white.

We now proceed into the constellation *Aquila.* In looking westward from *Al Tair,* a little *n,* across the intervening dark space to the *p* branch of the Milky Way, we see two tolerably conspicuous stars, ζ and ϵ *Aquilæ,* both 3 mag. according to the S.D.U.K. star maps, although ϵ seems very small for that magnitude. This star is pale orange, ζ being pale yellow. In the field with ϵ, *sf,* but much more *s* than *f,* is our next pair—

142. 263 P. XVIII. *Aquilæ.* 6″·5. 289°·1. 8½ and 10½. Pale yellow and sapphire blue. This pair seems to be only optical: it is called a "handsome test object" by Sm., that is, of course, for the light of smaller instruments. I noticed another star, as minute as the *comes,* a little way *n f.*

A short distance S. of ϵ and W. of ζ we shall perceive, in the finder, two small stars. The *n* of these, 10 *Aquilæ,* 6 mag., is in a remarkable neighbourhood, being closely preceded by a curiously arranged group of small stars, and followed at a greater distance by another scattered group. There is so much similarity of magnitude in these little assemblages as to convey the impression of mutual relation and dependence. The *s* of the two stars is our next object—

143. 11 *Aquilæ.* 19″·1. 240°·9. 7 and 10. Pale white and smalt blue (1832·61). I thought A yellow, 1850·7, 1864·76, 1865·63. So Dembowski, 1863·48. Σ called it greenish white, 1831·31. Sm. would have rated A 6 mag., Σ, 5·7, Demb. 5. His measures are 17″·427. 252°·15.

About two-thirds of the distance from *Al Tair* to ζ, we shall meet with another pair. In the finder a triangle of

* It is somewhat remarkable, as Sm. has observed, that so unimportant a group of stars should have been so early formed into a separate constellation.

6-mag. stars will be seen, followed by two other similar ones. The most *n* star of the triangle is—

144. 28 *Aquilæ*. 59″·8. 175°·7. 6 and 10. Dusky white and lilac blue. I noticed a minute pair, perhaps 10½ and 11 mags., somewhat wider, at a little distance *f*.

We must now advance into an intricate and puzzling region, *n p Al Tair*, where we must "keep a bright look out," or we shall be likely to miss some objects of interest. Few of the stars in this neighbourhood exceed 6 mag., and therefore any dulness of vision or atmosphere will greatly increase our difficulty. A careful study of the district with the finder will however enable us in a short time to master it all. We may as well begin with a little group (appearing as a small vertical pair in the finder), lying about midway between *Al Tair* and *α* and *β Sagittæ*, as always easy of recognition, from its peculiar character, though the *lucida* is inferior to several of its neighbours: it is also intrinsically a pleasing object, three stars forming a nearly vertical line: the furthest *n*, 6 mag. according to Star Map, but certainly small for that rating, white; this is *ψ Aquilæ*:—the central star 9 mag., perhaps purplish:—the *s*, 8 mag., orange or rosy, 255 P. XIX. We will next identify *χ Aquilæ*, a yellow star of a good 6 mag., and therefore fairly visible to an ordinary sight; a line drawn from *Al Tair* through its conspicuous and well-known 3-mag. companion *n p*, *γ Aquilæ*, alias *Tarazed*, points to it at about an equal distance beyond. Now between this *χ*, and *ψ* just mentioned, but a little E. of the line, we find—

145. 250 P. XIX. *Aquilæ*. 20″. 312°. 8½ and 14. White and blue. This pair possesses considerable interest from the probability that the attendant may be variable. Sm. calls it "an excellent test object," but it has certainly ceased to deserve that appellation, the smaller star now considerably outshining the *comes* of 257 P. XIX. (to be described presently as No. 147), which Sm. rates 10 mag. My attention was drawn to its unexpected size by a correspondent in 1862, and Mr. Knott found it, 1862·56, about 10·2, and visible even with 1½ inch of his great equatorial. Struve also rates it 9·5, corresponding to 10¼ Sm. The possibility of any mistake or misprint in the Bedford Catalogue is obviated by its description as a "test object," which it could not be in any other respect but that of *light*; and any suspicion of passing haze at the time is removed by the agreement of Sm.'s estimate of the mag. of A with those of Struve and Knott. It well deserves, therefore, to be attended to.

About 1½° E. of *χ*, and forming a tolerably equilateral triangle with *χ* and *γ*, or *χ* and *ψ*, we find—

146. *π Aquilæ*. 1″·7. 121°·3. 6 and 7. Pale white and

greenish. This "beautiful miniature of *a Geminorum*" was considered by Sm. and Σ to be fixed. Secchi, however, believes it to be in slow motion, from a comparison of the mean of his measures in 1855 and 1856, giving 1″·359, 118°·36, with Σ's, 1829·96, 1″·502, 120°·75. H has 124°·4 in 1783. Σ made both stars yellowish; Secchi yellow and blue. I have remarked a very minute star, perhaps 14 mag., a short distance *n p*: a good test for light.

Before leaving this neighbourhood we shall point out a star about 1° *n p* ψ. It is easily recognized as one of the more conspicuous of the region, and larger than ψ, nevertheless it has been omitted both by Flamsteed and Piazzi, the latter of whom especially has inserted many minuter objects in the immediate vicinity. Mr. Knott informs me that it appears in Lalande's Catalogue as No. 37394, 6 mag., and as 7·8 mag. in Bessel's Zones, whence Wolfers has concluded that it may be possibly variable. Mr. Knott now judges it to be 5¾ or 6 mag., and remarks its peculiar whiteness; to me, however, it appears very slightly tinged with yellow. In the *Uranometria Nova* of Argelander it is marked as a naked eye star, and he rates it 5·8 mag. A little *n* there are two open pairs of 9 mag. stars near together, forming a pretty group.

We now return to γ, or *Tarazed*, partly to notice its very fine full yellow colour, which may be set down as Y² of Sm.'s notation in his *Sidereal Chromatics*; partly to point out a curious chain of small stars a little to the S. of it, with a double flexure, reminding us of Secchi's curves in the galaxy; and partly to use it as a guide to a little pair lying a short distance *p*, and not so much *n*, being the nearest considerable star on that side in the finder. It is—

147. 257 P. XIX. *Aquilæ*. 4″. 276°·5. 8 and 10. White and smalt blue. A delicate object, and somewhat difficult for ordinary telescopes. Secchi considers it decidedly optical. A little *n* is a pretty group of four stars, the brightest of which is 253 P. XIX., 8 mag.

About 1⅓° *p Al Tair*, a little *s*, is a 7-mag. star, 252 P. XIX; a little further *p*, and rather more *s*, is—

148. 241 P. XIX. *Aquilæ*. 26″·8. 253°·7. 7½ and 9½. Pale topaz and lilac. I remarked another smaller and more distant *comes*, and the field with a low power is rich in minute points.

Our diagram will enable us, at a future opportunity, to refer to some other objects worthy of notice in this region; at present we shall only indicate one, which is not included in it, and which is rapidly departing towards the sun—

149. 15 *Aquilæ*. 34″·5. 206°·6. 6 and 7½. Yellowish white and red lilac. This very fine optical pair may be

readily met with from the directions given in our last No., p. 142, for finding Knott's Crimson Star.

OCCULTATIONS.

Oct. 4th, B. A. C. 221, 6 mag., 9h. 23m. to 10h. 29m.—9th, 130 *Tauri*, 6 mag., 8h. 46m. to 9h. 30m.

PRECIOUS STONES.*

Objects that possess remarkable beauty, and are at the same time rare, are most likely to be sought after and prized in wealthy communities, and hence the various kinds of minerals called "precious stones" have stood in high favour amongst civilized nations in ancient and modern times. A certain class of philosophers have endeavoured to ridicule the taste, and the same theorizers on social morals have denounced all ornamentation in apparel or domestic implements as a mere matter of vanity and ostentation. Sir Thomas More tells us that his Utopians "find pearls on their coasts, and diamonds and carbuncles on their rocks: they do not look after them, but, if they find any by chance, they polish them and therewith adorn their children, who are delighted with and glory in them during their childhood; but when they grow to years, and see that none but children use such baubles, they of their own accord, without being bid by their parents, lay them aside, and would be as much ashamed to use them afterwards as children amongst us, when they come to years, are of their nuts, puppets, and other toys." A great many things in *Utopia* evince a mind far in advance of the age, but in matters of clothing and decoration we should decline to accept the teaching of its learned author, who represents his model people as wearing garments made of skins and leather, and making them last seven years. "When they appear in public," he adds, "they put on an upper garment which *hides* the other." These Utopians "wonder how any man should be so much taken with the glaring, doubtful lustre of a jewel or a stone, that can look up to a star or to the sun itself." The argument thus put, obviously breaks down, and we are entitled to ask how any man who loves the brilliant effects of light in one class of natural objects can fail to admire them in another? and we should doubt any one's appreciating the lustre of a star or the variegated hues of the rainbow who told us that

* *Diamonds and Precious Stones:* their History, Value, and Distinguishing Characteristics, with Simple Tests for their Identification. By Harry Emanuel, F.R.G.S. John Camden Hotten.

he saw no beauty in the rich rays emanating from the ruby or the prismatic colours flashing from the diamond. Light is a thing of surpassing beauty, and any apparatus capable of displaying its gorgeous effects will charm the thoughtful and poetic mind, whether it comes from the workshop of the jeweller or that of the optician.

Rarity, beauty, and durability are the characteristics of precious stones, and from their extreme hardness the art of cutting and polishing them demands a very high degree of manipulative skill. Fashion, of course, rules the average taste in these matters, and amongst those crystallized antiquities the Chinese, stones, such as the jade, thought little of in Europe, are valued at an enormous rate. Those who saw the collection exhibited a little while ago at the Crystal Palace could not fail to have their opinion improved of the beauty of this material; and if a lifetime is spent in elaborately shaping and carving it, the work of art thus created may be handed down to distant generations uninjured by the lapse of time. We do not know what special incidents in Chinese history led their emperors and wealthy men to set such store by jade; but fine pieces are rare, and the mode of working them costly, and thus, in addition to the beauty of the article produced, two other qualities combine to magnify its worth.

With reference to the class of articles comprised in the European jeweller's list of precious stones, beauty, rarity, and durability are their general characteristics; but superstition in some ages, and fashion in all, have had their share in deciding the conventional value in which they have been held. A cut diamond or ruby represents a large quantity of human labour, which would cease to be exerted in such a direction unless it met with an average recompense in the shape of profit and price. The amount of this recompense of course depends upon the relative proportion of demand and supply, and we now find some gems much dearer than in former times, and others cheaper, as fashion has decreed the extent to which the wealthy should seek for them. That portion of the value of precious stones which depended upon superstition and errors of science may be left out of calculation in modern Europe, as no one now pays an extra price for an agate, in order that by wearing it his mind may be disposed to solitude, or for an amethyst to keep him sober, or for an onyx to preserve him from epileptic fits. Neither do modern criminals, amongst the wealthier classes, buy diamonds in order to reduce them to fine powder and poison enemies or rivals by mixing this material with their food. Magical qualities were ascribed by the Cabbalists and their followers to the mystical breastplate of the Jews, and even in recent times attempts

have been made to revive superstitions of an analogous kind, but without sufficient success to affect questions of price.

With reference to many of the old stories, we wonder that erroneous belief was not exploded by experiment or observation; but popular credulity has usually been determined by authority or association, and at the present day very few persons are in the habit of rigidly testing the theories they are induced to accept. In Cellini's time the art of poisoning was carried to a diabolical perfection, but faith was not exclusively put in preparations really competent to produce a lethal result; he himself tells us that he narrowly escaped being poisoned by a pounded diamond, through a needy jeweller having luckily substituted some other stone. He argued that the diamond preserved its angularity in the finest powder, which was not the case with less hard substances, and he took it for granted that the sharp particles of the diamond caused it to stick in the coats of the stomach and thus produce an injury of which the victim died. Such reasoning as this, without experimental verification, would satisfy many persons now, and it has a plausibility about it much greater than was usually needed to satisfy the ancient or mediæval mind.

The superstitions connected with precious stones would form an interesting chapter in the mental history of mankind, and in tracing them we should find fancies that were elegant, as well as opinions that were absurd. We may if we please retain the poetry without hostility to science, and let our jewels symbolize the good qualities they were said to confer.

The chemical composition of precious stones is pretty accurately known; but the mode in which nature produces them is not understood. A destructive analysis, or one which resolves any compound into so-called elements, or substances that have hitherto resisted decomposition, gives no clue to the manner in which it can be *re*-formed. In some simple cases it is sufficient to bring the elements together, as when a metal like potassium and gas like oxygen form a binary compound if simply left in contact for a short space of time. In a great variety of cases, particular compounds can only be produced by indirect methods, and by causing bodies to act upon one another in what is called their *nascent* state, that is to say, in the condition of activity exhibited at the very moment in which they are separated from a previous combination, or in which they themselves are primarily formed.

To make precious stones by artificial means we must combine their elements as nature has done, or, as in the case of the diamond, arrange their particles in the precise form.

We know carbon in the dense opaque condition of charcoal, in the transparent gaseous state of carbonic acid, and in

the solid crystalline state in which the diamond is found. Liquids, such as ether, alcohol, etc., show us this same substance (in combination) in another physical condition; but we do not know how to make a solution of carbon in any fluid that will deposit it on evaporation in a crystalline pattern, nor can we fuse carbon like sulphur, and obtain our crystals as it cools. Carbon is pre-eminently a vegetable material, and plants as they grow collect it from the air, and assimilate it in their tissues. United with oxygen and lime, or magnesia, carbon also abounds in terrestrial rocks; but it is remarkable that animals low in the scale of organization, like the coral polyp or the rhizopod, are the great agents in building up strata of this kind. How nature deals with carbon in the production of the diamond is imperfectly guessed, not known. This work may be slow, so that ages may elapse before one of the precious crystals may be completed, or it may, under appropriate circumstances, be rapid, though apparently seldom performed. It may be due entirely to chemical and electrical agencies, or, as many suppose, the organic life of the plant may in some way be concerned in the formation of the gem. However it is produced, it is the hardest substance known. Mr. Emanuel says "it is found both in regular crystalline forms and in an amorphous state. The crystals are principally octohedrons or dodecahedrons, the planes of which have frequently the peculiarity of being either concave or convex; sometimes they are worn, by attrition or other causes, into heterogeneous forms, being nearly round balls, occasionally transparent, or covered with a thick crust." Its specific gravity is about three and a half times that of water, and its beauty is due to its optical properties. It refracts light very powerfully, reflects it from its inner surfaces very perfectly, and disperses or spreads the ray so as to exhibit the rainbow colours in a very splendid way. Mr. Emanuel gives the following comparison between the diamond and glass:—

THE DIAMOND.

Refraction	2·487
Dispersion	0·38

GLASS.

Refraction	1·525
Dispersion	0·32

From these properties arises the beautiful effect of a diamond receiving light from one direction, and pouring forth its coloured rays in another direction, where the radiance may look all the brighter through contrast with surrounding shade.

If diamonds were large, cheap, and perfectly homogeneous,

they would be valuable for the purposes of the optician; but as they do not comply with these conditions, the glassmakers have been applied to, and they have made glass of very high specific gravity, and much more refractive than in ordinary kinds.

The diamond is usually spoken of as infusible, but this is open to doubt. Professor Miller says, "When the diamond is introduced into the flame of the voltaic arc it undergoes a remarkable change; as soon as it becomes white hot it begins to swell up, loses its transparency, suddenly acquires the power of conducting electricity, becomes specifically lighter, and is converted into a black opaque mass resembling coke." The swelling up looks very much like incipient fusion, and in an experiment made by Mr. Gassiot with a very powerful Grove's battery, the appearance of fusion was greater than had been previously noticed; and when the action of the battery was arrested, the change into "a substance resembling coke" had not taken place.

Mr. Emanuel follows the common practice of speaking of the diamond as *pure* carbon. Professor Miller, however, states that it is not so, and that when burnt "it always leaves a minute yellowish ash, which has been found to contain silica and oxide of iron."*

The practical use of the diamond in cutting glass is well known. For this purpose a particular angle is required, and diamonds possessing it are called "glaziers." It is astonishing what wonderful fine writing points can be obtained. Mr. Farrants tells us that with such a diamond point and Mr. Peters' machine the Lord's Prayer has been legibly written in the three hundred and fifty-sixth thousandth part of an inch. In this specimen the writing is so small, that in similar characters the Bible and Testament, said to contain 3,566,480 letters, could be written twenty-two times in the space of an English square inch. With a diamond Mr. Norbert rules his amazing lines on glass, putting them at the rate of seventy in one thousandth of an inch in the closest of his bands. Those who have not an opportunity of seeing one of Mr. Norbert's ruled glasses, should look at Mr. Richard Beck's† admirable plate, representing their appearance when magnified thirteen hundred times. Under this power the closest lines were almost in contact.

Another practical use of the diamond is the employment of it in a powdered state, to cut stones too hard for any other material to operate upon. The diamond dust forms teeth in the rim of a steel wheel used in these processes.

The art of cutting the diamond in regular facets was not

* *Elements of Chemistry*, vol. ii., p. 61, second edition.

† *Beck on the Microscope*. Van Voorst.

known to the ancients; it is ascribed to Louis von Berghem in 1456, The Dutch are now the great diamond cutters for the world, the chief establishments being at Amsterdam, where the largest mills, those of Mr. Coster, employ, as Mr. Emanuel tells us, five hundred to six hundred workmen. "To this firm was entrusted the cutting of the Koh-i-noor."

Mr. Emanuel observes, "the general form of the rough diamond is of two pyramids joined at the base: if a diamond is not naturally of this form, it must be made so by art." To cut diamonds, two stones are fixed with cement to the top of two sticks, and they are rubbed together till a facet is produced. "It must be understood that by this operation only the general outline of the form is made. A stone which would have, when quite completed, fifty-eight facets, including the table and culet, receives in cutting only eighteen, eight of which are the surfaces of an octohedron, or double pyramid, and are formed by taking away eight edges or angles of these eight surfaces, one for the whole table and one for the culet." The "table" is the flat face at the top of a brilliant; the "culet" is the small face terminating the pyramid into which the back of the brilliant is worked. In the rose form of cutting there is no "table." The "diamond polishing" on a steel disc, with diamond powder, gives the remaining facets required for the perfect form, and leaves the surface brilliantly smooth.

In Mr. Emanuel's book will be found a series of diagrams representing the different patterns into which diamonds are cut,.and he also gives views of the most famous diamonds in the world.

In the case of the diamond we have an instance of a very common material having its particles so arranged as to confer upon it very remarkable properties not exhibited by the same substance in other conditions. The ruby, the sapphire, the oriental topaz, the *oriental* emerald, and some other gems, are composed of a material as common as carbon—namely, *alumina*, the earthy oxide of aluminium, a metal now in frequent use, and the basis of all kinds of clay. In *Dana's Mineralogy* these gems are treated as minerals composed of uncombined alumina, but this is not absolutely true. Mr. Emanuel gives an analysis of a ruby, or red sapphire, which represents it as containing—

Alumina	98·5
Oxide of Iron	1·
Lime	.5
	100·

And it is probable that these minute quantities of extraneous

matter influence the mode in which the molecules of alumina are aggregated and the gem produced. Sapphires come next in hardness to diamonds, and rubies of large size, and of the "pigeon's blood" colour, are so rare as to command prices higher than those of diamonds. The *oriental* emerald, or green sapphire, is, as Mr. Emanuel informs us, "the rarest of all gems, and is scarcely ever seen." Even so large a dealer in these commodities as Mr. Emanuel "has only met with one specimen in the whole course of his experience."

The foolish whims of fashion in respect to gems seem to be displayed against the yellow sapphire, or oriental topaz. It is a jewel of remarkable beauty, and yet stated to be of very little value in commerce. Those who like gems for their beauty more than for their rarity, should take advantage of these freaks of fashion, and buy those things that have substantial merit when their commercial price is low. Yellow quartz is often called topaz, but it is a very inferior thing to the oriental gem. There are also Brazilian and Saxon topazes, which are fluorides of silica and alumina.

Thus far we have seen the two most valuable gems, diamonds and rubies, to be composed of very common materials in an uncommon condition. The opal may be added to this list, being a compound of silica, or flint, with a little water, and minute portions of iron, alumina, etc. The emerald—*not* the *oriental* one, or green sapphire—mingles with the common materials, silica and alumina, about 13 per cent. of glucina, a rare earth. Glucinum, of which glucina is an oxide, is a white malleable metal, which few chemists have seen. It fuses below the melting point of silica, and does not burn in air or oxygen. The name *glucinum* was given from the Greek, γλυκύς, sweet, in allusion to the taste of its salts.

Beryls and emeralds only differ slightly in composition. The finest emeralds come from New Granada, where they occur in a limestone rock. The colour of the emerald was supposed to depend upon its containing a small quantity of oxide of chromium, but Mr. Emanuel inclines to the opinion of Mr. Lewy, who ascribes it to the presence of a vegetable matter analogous to the chlorophyll of plants.

The zircon, hyacinth, or jacynth affords, like the emerald, a specimen of a gem containing a rare substance mixed with others that are common—the composition showing nearly 67 per cent. of zirconia, and the rest silica with a trace of iron. Zirconia is the oxyde of zircon, a metal about which nothing interesting is known. The jacynth is formed of various colours, from red to grey and white. The ordinary specimens look like a tawny emerald, and have little beauty, but fine ones may merit the favour which poets have sometimes bestowed

upon this gem. Tennyson speaks of the hilt of Arthur's famous sword, "Excalibur," as twinkling

> "With diamond studs,
> Myriads of topaz lights, and *jacynth* work
> Of subtlest jewellery."

And perhaps some jacynths might be worthy of such a place.

Garnets are silicates of alumina, iron, lime, magnesia, etc. In India, at Delhi, and in Bohemia they are marvellously cheap, but after paying half-a-dozen profits, they are not inexpensive articles to purchase at retail shops. The carbuncle is a garnet cut with the rounded "cabouchon" form, and when fine, gives much beauty for a moderate price.

To silica, one of the commonest minerals of the globe, we owe, in addition to the opal already spoken of, a host of gems of more or less beauty and value, such as the amethyst, the cairngorm, the chrysoprase, the onyx, the sardonyx, the carnelian, agate, cat's-eye, jasper, bloodstone, etc. Quartz gems are usually of little value, though, as Mr. Emanuel states, "a solitary specimen of fine quality may bring a large price."

The turquoise is a phosphate of alumina, with a little iron, copper, etc. The best come from Persia, but the fossil bone turquoise, or odontolite, .comes from Languedoc, and may deceive the unwary, though it is softer, of a different texture, and of much lower price.

The felspar minerals are essentially silicates of alumina and potash, and they give us one gem which, when fine, is of remarkable beauty, and strangely neglected by jewellers, and by the public—we mean the moonstone, the best of which comes from Ceylon. It should be clear as glass, hard enough to scratch glass easily, and also to scratch quartz; in certain directions its curious internal structure should give brilliant flashes of light of an exquisite *mooney* tint. A lady of our acquaintance recently became possessed of four fine specimens of this stone, which she had simply mounted in a star-shaped brooch, with four carbuncles and a small opal in the centre. The effect was remarkably good, and we recommend those curious in such matters to look out for choice moonstones while fashion is blind enough to let them go cheap.

Mr. Emanuel deserves a good word from us before we conclude. His work on gems is a very elegant production, supplying just the sort of information that purchasers and possessors of jewellery will like to have. It gives an account of all the most interesting of the precious stones; describes their quality and composition; the modes of cutting them, etc., etc. It is illustrated with many plates and diagrams, and is a handsome book for the drawing-room or the boudoir.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from Page* 126, *Vol.* viii.)

1402. About February 8, a comet appeared, which afterwards became very brilliant, so much so as to be visible in the daytime; it lasted till the middle of April. It appears to have been first seen in the S.W., setting in the W. At the beginning of March it was in Aries, and was seen from two and a half hours before, till three hours after sunset, or even later. Subsequently it was seen in the N.W. on Palm Sunday, March 19; its size was prodigious.—(Walsingham; Poggius, *Historia Florentina;* Ebendorfferus, *Chronicon Austriacum.*)

1402. [ii.] From June to September, an immense comet was visible in the W.—(Ducas, *Historia Byzantina.*) The descriptions are long, but contain nothing of practical value. The comet was visible in the daytime, and perhaps it attained its maximum brilliancy at the end of August. This, or the preceding, was regarded as the sign, by some even the cause, of the death of John Galeas Visconti Duke of Milan.—(*Annales Forolivienses.*)

1406. Some time between January and June, a comet appeared in the W. for several nights.—(*Chronicon Bremensis.*)

1407. On December 15, a comet was seen.—(Biot.)

1408. On October 16, a comet, or something like one, was seen.—(Antonius Petrus, *Diarium Romanum.*)

1429 or 1430 (preferably the latter). A terrible comet appeared on August 24.—(Kaempfer, *Historie du Japon,* ii. 5.) Gaubil mentions a great star having been seen for a week in October, November.

1431. On May 15 or 27, a comet 5° long was observed in the feet of Gemini.—(Ma-tuoan-lin.)

1432. On February 2, a comet about 10° long appeared. It "swept" the region near *a* Cygni, and disappeared on February 12. On February 29, another comet (doubtless the same, after its P. P.) became visible for seventeen days.— (Biot.)

1436. James I. of Scotland was assassinated on February 20, 1437. During the previous autumn a comet was seen.—(Boethius, *Hist. Scot.* xvii.)

1439. [i.] On March 25, a comet was seen. It traversed Hydra, Leo, and Cancer. On April 2 it had a tail 5° long.—(Biot.)

1439. [ii.] On July 12, a comet about 10° long appeared near the Hyades for seven weeks.—(Biot.) Perhaps the preceding after its P.P. A comet, lasting one month, was seen this year in Poland.—(Duglossus *Historia Polonica,* xii.) In Japan also a comet was seen.—(Kaempfer, *Hist. Japon,* ii. 5.)

1444. A comet appeared about the time of the sun's solstice, or on June 15 according to others.—(G. Fabricius, *Rerum Memorabilium Germaniæ.*) On August 6, a comet 10° long was seen to the E. of Leo; it became longer day by day, till August 15, when it entered the sidereal division of α Virginis and disappeared.—(Biot.)

1452. On March 5, a comet appeared near the Hyades.—(Gaubil.)

1453. On January 4, an extraordinary star appeared near the nebula in Cancer (Præsepe). It went slowly westwards. —(Biot; Gaubil.)

1454. In the summer, a comet like a sword became visible in the evenings after sunset.—(Phranza, *Chronicon De Rebus Constantinopolitanis,* iii.)

1457. [i.] On January 14, a comet with a tail ½° long was seen in the division of ϵ Tauri. It went to the S.E., and on January 23 it disappeared.—(Biot; Pontanus, *Historia Gelrica,* ix.)

1457. [ii.] In June, a comet appeared in the 20th degree of Pisces.—(*Chronicon Nurembergense, etc.*) The conclusion seems unavoidable, that there were two comets in June, and that this is not identical with the one computed by Hind.

1458 or 1459. (Probably the former.) In June, July, a comet appeared in Taurus [?].—(De Mailla, x. 236; Rockenbackius, *Excerpta Cometarum.*)

1458. On December 24, a star appeared in the division of α Hydræ; it went to the W. till December 27, when it became faint; it was near α, γ, ζ, η Leonis. On December 31, it had a tail ½° long; it "attacked" λ (or ϕ) Cancri. On January 12, 1459, it disappeared in the division of μ Geminorum.—(Biot.)

1460. James II. of Scotland was killed on August 3, 1460. The evening before his death, a very brilliant comet with a long tail was seen.—(Boethius, *Hist. Scot.* xviii.)

1461. On July 30, a white star appeared near *k, l, g* Tauri Poniatowski. On August 2, it transformed itself into a vapour and disappeared.—(Biot.)

1463. In this year (no month assigned) a comet was seen near τ and υ Virginis.—(Gaubil.)

1464. In the spring, a comet was seen in Leo.—(Gaubil.)

1465. In March and April, a comet with a tail 30° long was seen in the N.W.—(Biot; Kaempfer, *Hist. Japon,* ii. 5.)

1467. In October, a comet was seen above Pisces, "as if it had been formed in Cancer." Rainy weather prevented its being often seen.—(*Chronicon S. Ægidii Brunswicensis.*)

1468. [i.] On February 24, a comet was seen near Ursa Major.—(Gaubil.)

1471. In autumn, a very great comet was seen in Poland. It was in the latter part of Virgo, and in Libra, and lasted a month.—(Michovia, *Chronica Polonorum,* iv. 62.)

1476. From December, 1476, to January 5, 1477, a small comet was visible.—(Ripamontius, *Historia Urbis Mediolanensis,* vi.)

1477. In December, a comet appeared.—(*Chronica Bossiana.*)

1478. In September, a great comet was seen.—(*Chron. Boss.*)

1491. On the Festival of the Epiphany (January 6), a comet was seen between the 20th and 30th degrees of Pisces. Its head was small, but its tail was long, though faint. It followed the sun after its setting, and the tail was turned towards the E. on January 17, between six and seven hours of the evening. Bernard Walther, at Nuremberg, observed the comet in Aries.—(Michovius, iv. 64; Regiomontanus, *Scripta Mathematici.*) In China, on January 13, according to Gaubil, a comet was seen *in* Cygnus. If this refers to the same object as was seen in Europe, it can only be understood as meaning that the comet reached to Cygnus.

1495. On January 7 a star was seen near θ, ρ Ophiuchi; it travelled with a slow motion till February 20, when it entered the division of α Aquarii.—(Biot.)

1502. On November 28, a star appeared near Pyxis Nautica. From the division of υ^1 Hydræ it directed itself towards that of α Crateris. On December 8, it disappeared.—(Biot.)

1503. At about the time of the Festival of the Assumption of the Virgin Mary, August, a comet was seen. Its tail pointed towards the E.—(*Chronicon Waldsassense.*)

1505. A comet was seen in Aries. It lasted only a few days.—(Mizaldi, *Cometographia.*)

1512. In March and April, a comet appeared.—(*Chronicon Magdeburgense.*)

1513. From December, 1513, to February 21, 1514, a comet was visible. It passed from the end of the sign Cancer to the end of that of Virgo, and was seen all night.—(Vicomercatus, *Commentarii, in lib Aristot. Metcor.*)

1516. The death of Ferdinand, the Catholic, King of Arragon (January 23), was announced by a comet which lasted many days.—(Bizarus, *Historia Genuensis,* xix.) Others say the comet was only visible for a few days.

PROGRESS OF INVENTION.

Production of Formic Acid for Industrial Purposes.—The use of this important acid has been more or less limited hitherto, by the difficulty, and consequent cost, of its production. The mode of obtaining it devised by M. Lorin leaves nothing to be desired, either with regard to simplicity or cheapness. His process is founded on the power which glycerine possesses of producing formic acid by the decomposition of oxalic acid; but he applies the principle in such a way as to obtain directly formic acid of great strength. He heats a mixture of ordinary oxalic acid and anhydrous glycerine; reaction begins at 79° Cent., and attains a maximum at 90°; carbonic acid is disengaged, and an aqueous fluid charged with formic acid passes over. Adding a new quantity of oxalic acid to the glycerine, some time after the evolution of carbonic acid has ceased, causes decomposition to recommence, and a fluid still richer in formic acid passes over. Successive additions of oxalic acid to the glycerine at length causes the formic acid in the receiver to be of the strength required for crystallization. The process is very simple; and as the evolution of carbonic acid marks its phases sufficiently, it is unnecessary to pay any attention to the temperature. The same glycerine might be used for the production of any amount of the acid, except that the impurities always found in the oxalic acid would lead to waste. The same glycerine has, however, been used continuously night and day for months. The process just described affords a product containing 56 per cent. formic acid; if anhydrous oxalic acid is used, the product will contain 75 per cent. acid. Decomposition will commence at 50° Cent.; and care must be taken to apply the heat cautiously, so as to prevent an inconvenient swelling up of the mass. Monohydrated crystallizable formic acid may be obtained by acting on formic acid of 70 per cent., at an elevated temperature, with anhydrous oxalic acid, and distilling. It crystallizes when the temperature is lowered sufficiently.

Formic Ether.—The process just described supplies a means of producing formic ether, a fluid having a remarkably agreeable odour, with great economy. Oxalic acid and alcohol, in nearly equivalent proportions, corresponding to the ether required, are added, at the same time, to saturated glycerine, and submitted to the proper temperature. The formic acid, according as it is produced, combines in the nascent state with the alcohol. The condensed vapours are to be returned to the retort when the decomposition of the oxalic acid is complete, and the ether is to be distilled over: it may be purified in the usual manner.

Silk Producible in these Countries.—Hitherto the economic production of silk has been confined to hot countries; the Acclimatization Society of Paris has, however, recently introduced a silkworm (*Bombyx Cynthia*) which will thrive well even in northern climates, being unaffected by rain, wind, or frost; the only effect, indeed, produced by the genial nature of the climate being the more

rapid production of the cocoon. This promises to open a new and profitable branch of industry for Ireland and other portions of the British dominions. The Ailanthus, upon the leaves of which the silkworm feeds, thrives well in this country, and has already been introduced largely into France. It grows rapidly, and its wood is of the very best description for any industrial purpose. The young worms require to be kept in the house for a few days after having been hatched; and at every period of their existence they require moisture. The silk, though an excellent textile material, is not equal to that obtained from hot countries; and some difficulty has been experienced with the process of winding it, since, as the cocoon is open at one end, it will not float in water; and, having no gumming matter, it affords only spun silk. It is, however, easily bleached, and it takes dyes extremely well.

Substitutes for Ivory, etc.—An excellent substitute for ivory, bone, horn, etc., may be obtained by cutting caoutchouc or gutta-percha into small pieces, after it has been thoroughly washed, and then dissolving it in well-closed vessels with chloroform, or some other solvent. When the solution is complete, chlorine is passed into it, until the whole assumes a bright yellow tint: after which the product is to be washed well with alcohol. It is then to be augmented in bulk by means of a small quantity of chloroform and agitating; and chalk, oyster shell, marble, heavy spar, allumina, or sulphate of lead, in the state of fine powder, is to be added, to an amount dependent on the density and tint which are required. Having been kneaded, the mass is to be formed into blocks of a size suited to the purpose for which they are intended, and subjected to pressure. The result answers well for buttons, knife-handles, etc., and may be cut, turned, and polished in the same way as ivory.

Catalytic Action of Potatoe-peel, etc.—Schönbein has recently discovered that catalytic power is not confined to diastase, gluten, saliva, and a few other organic substances, but is very generally diffused through the animal and vegetable kingdoms, and is possessed in a very remarkable degree by potatoe-peel, lettuce, the root of dandelion, etc. So effective is potatoe-peel, that if kept for ten or twelve hours with starch, at a temperature of from 45° to 50° Cent., the starch will all be changed into sugar.

New Method of Removing Hair from Hides.—The ordinary method of removing hair from hides is tedious and troublesome, and leads to considerable loss from abrasions of the hide. These inconveniences have been obviated by a process which has been recently invented. The hides are placed in a close chamber, in which water is violently scattered about, so as to be brought into such a state of minute division, and form a species of vapour, which, no mode of escape being afforded to it, enters into the pores of the hides. In a few days they become so soft, that the hair may be removed so easily that three times as many skins may be deprived of it in a given time, as by the usual method, and without the smallest tendency to putrefaction, or injury to the skins. The rapidity of the process depends on the minute division of the watery particles, the closeness with which they are brought into contact with the

hides, and the completeness with which the air is excluded. As hides prepared in this way require somewhat more bark in tanning, the leather they afford is of a very superior quality.

Oxidation of Fat Oils by the Action of the Atmosphere.—It has long been known that fat vegetable oils, when exposed to the air, thicken, and become more or less hard, by absorbing oxygen; the amount and rapidity of the effect produced on them being greatly modified by the temperature, and the degree of exposure to light. M. Clöez, having made numerous experiments on the precise effects of heat and light, has added considerably to the very large amount of knowledge we have obtained regarding these oils from the researches of Chevreul and other able and indefatigable investigators. M. Clöez examined four kinds of oil—two non-siccative and two siccative; the former being sesame and castor oils, and the latter poppy and linseed oils. He endeavoured, by every possible precaution, to render the conditions of the different experiments exactly similar, so that perfectly reliable comparisons might be made. The exposure to air, in every case, continued for 150 days; in some of the experiments white, in others coloured light was admitted to the oil, in others light was entirely excluded; and the augmentation of weight was noted at different intervals. It was found that for thirty days the oil exposed in white glass increased rapidly in weight; that it increased nearly to the same extent in blue glass; very little in red or green glass; and not at all in darkness. After thirty days the increase in weight was greater with blue than with white glass; and after a longer or shorter period the increase was greater with red and green, than with white and blue glass. After some time, the rapidity with which the weight augments becomes greater: after 120 days the augmentation with poppy oil was found to be about double what it had been after 60 days; but after 160 days it was more than trebled. Heat greatly modifies the effects of exposure. When linseed oil was heated for six hours to 100° Cent. in a water-bath, in a current of atmospheric air, not only was the weight increased, but vapours of a suffocating odour were produced. It is an important fact connected with the art of painting, that the oxidation may be very much accelerated without the application of heat, by the addition of a small quantity of oil of the same kind, which has been previously thickened by exposure to the atmosphere. Oil for painting may therefore be prepared so as to be perfectly colourless, and consequently to produce no diminution of the brilliancy of the colours.

Illuminating Gas from Vegetable Refuse.—The utilization of the refuse left after the making of cyder and perry is now being very successfully effected in France. It had been hitherto good for nothing, and in some cases was a source of actual inconvenience and loss. The same thing is more or less true of the waste left from the apples and pears after making cyder and perry in these countries. This otherwise worthless material is now employed in the manufacture of an illuminating gas of most excellent quality, its light-giving power being of a high order, and its combustion not in the least injurious to painting or gilding, since it contains no

sulphur or other mischievous ingredient. The apparatus required for its production is of the very simplest kind, consisting merely of a furnace, a still head, and a contrivance which serves both to wash and purify the gas, and to retain it until required for use. It is evolved at a temperature very far below that required for the destructive distillation of coal, resin, etc., and therefore the cost of fuel is insignificant, and the wear and tear of the apparatus next to nothing. A ton of the refuse matter yields about seventy cubic metres of gas.

Novel Application of Electricity.—It is undoubtedly a matter of considerable importance in many harbours that it should be known with certainty by those about to enter or leave, when there is a sufficient depth of water for the purpose. M. Emile Duchemin has devised a very simple application of electricity, which answers admirably for this purpose. He attaches to a small float a plate of carbon and a plate of zinc, and connects these respectively with the wires of an electric bell-ringing apparatus. Throwing the float and battery into the sea will cause the bell to ring. When therefore they are suspended at any required height, within reach of the tide, as soon as the water has risen sufficiently to set the small battery in action, the bell will ring; and thus the apparatus may, at pleasure, be made to indicate any state of the tide. By using a sufficiently large float and battery, it is evident that an electric current will be generated sufficient to sound a bell of considerable size, or, by means of Geissler's tube, to produce a light which will be seen from a great distance.

A simple Method of producing Ice on a Large Scale.—Refrigeration is now used extensively for industrial and other purposes. Solid matters dissolved in fluids are thoroughly separated from them by freezing; and the principle has been applied with great success to the obtaining of the sugar from syrup, etc. A simple and economic method of producing a freezing temperature is therefore of considerable importance. A new method of effecting this has recently been tried in Paris, with very successful results. It depends on the circulation of ether; but unlike the other processes in which this is used, it requires no pump. The amylic ether which is employed is obtained and purified in the usual way. Its vapour is transmitted at a pressure of from five to seven atmospheres into a vessel, in which it becomes liquified. When a cock is opened for the purpose, it passes from this vessel into spiral ducts which surround the reservoir filled with the water, etc., which is to be frozen, and immersed in a solution of salt, which is not frozen even by a very low temperature. After having been vaporized in the spirals, the ether vapour passes into three large cylinders containing sulphuric acid, by which it is absorbed. A portion of the ether is always ready to be driven from the saturated solution containing it, by means of the heat which is supplied by superheated steam, into the vessel in which it is again liquified, preparatory to its being again used for the production of cold by evaporation. A machine calculated to form in this way 200 kilogrammes of ice in an hour has been constructed for the separation of the salts contained in sea-water.

STERROMETAL.—This important alloy possesses some valuable properties which make it well deserving of attention. It may, in many cases, be substituted for bronze, iron, or steel, with great advantage: and is likely to prove valuable to the makers of various kinds of instruments and machinery. It is formed by fusing together from 55 to 57 per cent. copper, from 40 to 42 per cent. zinc, 1·8 per cent. iron, and from 0·15 to 0·8 per cent. tin. The colour of this compound is very similar to that of gold. The cast metal is rendered malleable and ductile by hammering or pressure, at a red heat—a higher heat would produce brittleness, and a lower would injure the texture. The tenacity of the cast metal is equal to the support of 42·29 kilogrammes the square millimetre; of the malleable, to the support of 53·99 kilos.; and of the ductile, to the support of 59·72 kilos. It takes a fine polish.

BLACK PHOSPHORUS.—Hitherto we have been accustomed to consider white as the colour of perfectly pure phosphorus, or red when the phosphorus is in the amorphous state. There is now, however, good reason to believe that its normal colour is black. Long ago, Thenard obtained black phosphorus; but the process he used was more or less uncertain, and it was never repeated with success by other chemists. M. Blondlot has, however, discovered an infallible process for obtaining black phosphorus. He purifies phosphorus of the ordinary kind by repeated distillations, in a sand-bath and in a current of hydrogen; the yellow or impure portion, which is volatile—and therefore not separable by distillation—being changed into red amorphous phosphorus, which is fixed, by exposure for several days to insolation, previous to each repetition of the process of distillation, and the product being received into distilled water, kept at 90° Cent. When the phosphorus is become thoroughly pure, if slowly cooled, it will on falling to 42° be a white mass, which, when 8° or 10° are reached, suddenly changes to black. Black phosphorus becomes colourless again by fusion, but recovers its blackness if slowly—and sometimes if suddenly—cooled. It is like common phosphorus, except that it is more stable, softer, and more flexible. It becomes coated with white, in water; and with red, in the atmosphere: but a single distillation renders it, in each case, again black. Very old phosphorus—it is supposed by some kind of spontaneous purification, depending on a change in its molecular condition—is very often changed to black throughout its whole mass, except the outside, which is red.

MISCELLANEOUS.—*Alloys of Manganese.*—An alloy consisting either of two atoms of manganese and one of iron, or of four of manganese and one of iron, is harder than the hardest steel, is of a colour between that of steel and silver, and is capable of receiving a high polish. It fuses easily, and is not oxidizable by the atmosphere. It may be formed by keeping a mixture consisting of oxide of manganese, powdered charcoal, and cast or wrought iron in a state of tolerably minute division, at a white heat, for some time in a graphite crucible; the whole having been covered up in the crucible by a layer of common salt, or of some other substance

suitable for excluding the air. A compound possessing the good qualities of iron, and not acted on by the atmosphere, is likely to prove invaluable. Alloys of copper and manganese may be obtained in a similar way, and some of them possess very important properties.——*Generation of Heat by Friction.*—This is a subject which is exciting some interest in France at present; and although, generally speaking, the production of motion by means of heat, and the change of this motion back again into heat, is too circuitous a mode of proceeding to be economical, there may be circumstances in which it would be preferable to any of the ordinary methods of obtaining heat. M. Pelon's contrivance for the purpose consists of a truncated cone of wood, covered with hemp, and revolving within a similar cone of copper, in such a way that considerable friction arises from the rubbing of the hemp against the copper, while at the same time this friction is prevented from becoming inconveniently great by a lubrication which is effected by an ingenious application of centrifugal force. The whole is placed in a metallic casing, within which the air to be heated is made to circulate slowly. A large apartment is said to have been effectively and very rapidly warmed by this apparatus with a trifling expenditure of force; and it seems applicable to the heating of railway and other carriages, the cone of wood being kept in motion by the revolution of the carriage wheels.——*Evaporation by Mechanical Means.*—The evaporation of solutions for the production of crystals, etc., constitutes a serious item of expense. It is found that this may be greatly lessened by a concentration or preparatory evaporation effected by mechanical means. For this purpose horizontal cylinders are placed, one at the top and the other at the bottom of a frame, the lower cylinder being immersed in the liquid to be evaporated. Over these cylinders are stretched a number of vulcanized India rubber cords; and when the upper roller is turned by the hand, or by other suitable means, these ascend, carrying up with them portions of the fluid, and bringing them into contact with the air, which—especially under exposure to the sun—causes large quantities of moisture to be dissipated. The effect thus produced is found much cheaper than when obtained by the agency of heat in the usual way. ——*Artificial Leather.*—This is now formed by mixing cuttings of leather with an equal bulk of solution of caoutchouc, spreading the mixture, to a desired thickness, on plates of metal, and when the outer surface has become sufficiently hard, passing the whole between rollers, then drying at 90° Fahr. The artificial product thus obtained may be pressed into any desired shape in moulds, and used for any of the purposes to which leather is applied; it may even be vulcanized, by a very simple process.——*Cocaine.*—This substance, which is not long discovered, is one of that class to which theine, caffeine, etc., belong. It is obtained from coca, the leaves of the *Erythroxylon coca*, a South American shrub, which are chewed very generally by the inhabitants of those regions where it grows, and is remarkable, not only for enabling persons to endure the want of food, but for being in a surprising

degree a substitute for it. If introduced into these countries, it might, to some extent, supersede tobacco, and advantageously; but its flavour, though not actually disagreeable, is such that it never can come into very common use. Its consumption is another instance of that extraordinary instinct which has led the different portions of the human race to agree in selecting, without knowing it, some one source or another of a highly nitrogenized, and, for some reason not yet certainly known, most important compound. ——*Incompressibility of Water.*—Baron Séguier has discovered that if a glass cylinder is plunged vertically into a vessel of water, in such a way that some of it will be in, and some above the water, and a ball of lead is allowed to fall within it, along its axis, the glass will be cut horizontally on a level with the surface of the water, the part above being quite uninjured, and the part below being broken in pieces longitudinally. The effect is due to the incompressibility of the water, of which it is a curious illustration. Similar phenomena, on a large scale, have been well known for some time. A cannon exploded under water produces the most violent effects on subaqueous constructions which are near it; and rocks are now blasted under water by exploding gunpowder near them, instead of within cavities formed in them.——*New Mode of Preparing Grains.*—The ordinary method of removing the outer coating of grain is attended with great waste of valuable constituents of the corn. A very favourable official report has been lately made on the means used by M. Poissant for avoiding this evil. His apparatus consists of a hopper, which conduct the grain into a cylinder, where it is subjected for some minutes to a beater, which makes nearly four hundred revolutions a minute. The pellicle is thoroughly separated in this way, and is removed by a current of air, and along with it dust, and matters due to cryptogamic vegetation; and after which it is ground—only the one thirty-first of the total weight being lost during the process. The bread made from the flour is not, perhaps, so white, but it is more wholesome than with grain treated in the ordinary manner.——*New Break.*—Every one must have remarked that when a carriage is descending a hill, the front of the pole is thrown up by the efforts of the horses. This fact has been applied to the construction of a very powerful break, which derives its force from this movement of the pole. And, therefore, it is effective, in proportion to the efforts of the horses—that is, to the necessity for it. At the same time it is under perfect control.

ARCHÆOLOGIA.

At the recent meeting of the British Archæological Association at Durham, under the presidency of the Duke of Cleveland, the Rev. Prebendary Scarth, of Bathwick, Bath, communicated a discovery he had recently made in Gainford Church, in the county of Durham,

of a ROMAN VOTIVE ALTAR, which had been used for material in building. It was dedicated to Jupiter Dolichenus. Several altars have been found in Britain dedicated to Jupiter under this name, which is said to have been derived from Doliché in Macedonia, where there were extensive iron mines. This makes about half a dozen Roman inscriptions to Jupiter Dolichene found in this island, and, as we understood Mr. Scarth, he considers that they generally mark the neighbourhood of iron mines worked by the Romans, as being placed under the protection of the god under this character. Perhaps, however, we ought to take this suggestion with some reserve. It was a common practice with the Legionaries to dedicate their altars individually to the deities who presided over the native country of each, and in all these cases the altar, or votive tablet, may have been offered by a soldier who came from the district of Doliché. The presence of mines in the localities where they are found is easily accounted for. We know that the Roman mines were worked by men generally of bad character, condemned criminals, degraded slaves, and others, whom it must have required an armed force to hold in check, and there were no doubt small military posts in their neighbourhood. It may be added, that the stone on which this inscription was cut has been somewhat mutilated and defaced, and that, although Mr. Scarth's explanation was perfectly satisfactory as far as it went, a part of it has not yet been fully deciphered.

The ROMAN REMAINS found on the brow of a cliff at FILEY in Yorkshire in 1857, and described in a brief paper by Dr. W. S. Cortis, were brought for exhibition at the meeting at Durham. They were numerous, and of a miscellaneous character, consisting of upwards of forty coins, in third brass, of the later emperors; of a quantity of bones and pottery, among which was one fine vessel of the Durobrivian ware; of oyster, limpet, and mussel shells; and of various other articles, among which were several legs of fighting cocks, showing that the well-known love of the Romans for cock-fighting had reached even this remote corner of the earth. Much charred wood was found scattered about, and other indications of burning, so that whatever building had stood on this spot, apparently a watch-tower or lighthouse, had perished in a conflagration. Five square bases of columns were found, arranged in a parallelogram, which measured seventeen feet by fourteen, one at each corner, and the fifth in the centre, which had evidently supported a superstructure. A smaller column, on the northern side, seemed to indicate the position of a doorway. Close to the eastern stone a bit of shale was found, which had broken off a larger piece, in the middle of the one side of which was drawn a large A, with scrawls which appeared to have no meaning. On the other were parts of two lines of an inscription, of which the following words remain:—

CÆSAR SE
QVAM· SPE

It has been written probably by some individual in mere playful-

ness, and has not been, as Dr. Cortis thought, an inscription of importance. He conjectures that Filey Bay was the Ευλιμενος Κολπος of Ptolemy, which Richard of Cirencester, merely translating Ptolemy's name, calls Portus Felix. The next promontory, now called Filey Brigg, is identified by Dr. Cortis with the *Brigantium extremum* of the same writer, the extreme southern point of the country of the Brigantes on this side, and the boundary between them and the Parisi; and he believes that the remains described above mark the site of the Prætorium of the Romans.

On the subject of our recent remarks on the use of the term FRITH-GEARD we have been favoured with some observations by our correspondent J. C., which hardly bear relation to what we had said. If our correspondent will turn again to our article he will see that our remarks applied to Anglo-Saxon words, and the practices of the Anglian population of Northumbria, and not to Cornish words or customs. However, his notes on the latter seem to us sufficiently interesting to deserve publication, and we give them gladly. He says:—

"At the present time, in Cornwall, there are numerous words in daily use which have their proper meaning in the more ancient language of our island, long before the Saxons found an entrance into it; to which also may be joined ordinary practices and opinions; and among the former these two words find a place, as does the thing also that is signified by the former of them. With us of the West a freith signifies the very opposite of a circle of stones, or of stones in any other manner of arrangement; and it can be only remotely connected with a circle of any sort. It refers, in the first instance, to the materials of which the erection is formed, and then to the manner in which they are intertwined together, while the object kept in view may be of several sorts; but easiness of formations constitutes an important particular. It is, in fact, a wattled work, made of interlaced twigs and branches of trees, supported by posts driven into the ground, and the whole forms a fence to prevent the passage of man or beast. It may serve the purpose of its erection for a considerable time, but of course is less substantial and enduring than a stone wall; but it has the advantage that, when repair is required, it is soon and easily accomplished by those who might find it difficult to repair a substantial wall, and it is also speedily removed when necessary. The geard, or, as it is now even sometimes expressed, a gaard, is only remotely a yard, but it always signifies a defence; and certainly there was a time when the word was applied to a castle, as well as to any inferior enclosure intended for protection. It is probably the root or parent of our modern terms, to guard and gird; and for some purposes a freith or wattled erection might be as effectual as if it were constructed of more solid materials.

T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

THE BRITISH ASSOCIATION.

THE annual meeting of the British Association for the Advancement of Science has been held this year at Birmingham. Professor Phillips, in his inaugural address as president, gave an admirable *resumé* of the progress of science during the past year. Among the more valuable communications to the different sections, may be mentioned Professor Jukes' Lecture on the Possible Extent of the Coal Measures below the Red Rocks of the Midland Counties of England.

The continued prosperity of this country so greatly depends on the supply of mineral fuel, that the recent prognostications of certain eminent geologists as to the possibility of that supply being exhausted in less than a century, at the continuously accelerated rate of consumption, have given rise to much uneasiness.

Professor Jukes mentions that there are doubtless large tracts of coal measures containing good beds of workable coal under the Red Rocks of the Midland Counties, but that there are also many parts where the coal measures do not exist under these rocks. The Carboniferous Limestone or coal formation was formed in a sea which certainly spread over the greater part of the British Islands; but at the time of its existence, an island, or, perhaps, numerous islands, consisting of lower and previously-formed beds, stretched across the Midland Counties, from Wales through Shropshire, Staffordshire, and Warwickshire into Leicestershire, and, perhaps, extended still further south and east. In consequence of these islands existing in the sea, little or no carboniferous deposits took place in the districts named.

Subsequently, however, this land was depressed beneath the water in which the coal measures were formed, and the uppermost beds of that group spread in level sheets over the land. Since this deposition, a great erosion and destruction of the coal measures has taken place, and the most important subjects now to be determined are: Under which part of the New Red Sandstone that now overlies the coal measures do workable coals still remain? How thick is the New Red covering in those parts? Do Permian rocks occur between the New Red and the coal measures? These are points which can only be answered by those who possess an accurate knowledge of theoretical and practical geology. Professor Jukes states distinctly, that any one intending to try for coal beneath the Red Rocks, must be prepared to sink boldly one thousand yards before there is any hope of meeting with the coal measures. There is then, a chance, and a chance only, that the adventurer may find good workable coal beneath him. But there is also a chance of his finding the coal measures destitute of valuable workable coal; or of his not finding the coal measures at all, but, in consequence of their

removal by denudation and erosion, coming down upon some of the Lower Palæozoic rocks.

As such hazardous speculation would be beyond the sphere of private enterprise, Professor Jukes thinks that the explorations ought to be made at the national expense.

In his inaugural address to the chemical section Professor Miller recounted the chemical discoveries and progress of the past year, and alluded to many new applications of the science to the useful arts, particularly to the improved methods in the voltaic deposition of metals. He stated that Weil had, by the use of a solution of tartrate of copper, coated steel and iron with a tough closely-adherent sheathing of the metal, by simply suspending the articles to be coated in the copper solution, by means of a wire of zinc, no battery being required; and that lead and tin may be also deposited on iron or copper in a similar manner, provided the oxides of those metals be dissolved in a strong solution of caustic soda.

Professor Miller described the singular experiments of Deville and Froost, proving the permeability of metals to gases at high temperatures. Thus platinum and iron when white hot are perfectly porous and readily permeated by hydrogen, but recover their usual character as they cool. This passage of hydrogen will take place at a white heat through a tube, the thickness of which is one-sixth of an inch. These discoveries have an immediate practical bearing, as they prove that air pyrometers constructed of metal are not to be relied on. Glazed porcelain, however, is not open to the same objection, as it appears perfectly impervious to gases at all temperatures to which it has been exposed.

Sir Henry Rawlinson delivered the inaugural address in the Geographical Section, and recounted the important geographical events of the past year, which have been recorded in the pages of the INTELLECTUAL OBSERVER.

Sir Henry Rawlinson mentioned that Mr. Greenhow, an American merchant, had fitted out an expedition, headed by Capt. Hall, to proceed in search of the remains of the Franklin expedition. Capt. Hall is at present on the track of Franklin, and, it is to be hoped, will discover any further remains that may exist of that ill-fated exploration.

In the department of Statistics and Political Economy the address was read by Lord Stanley, and in that of Mechanical Science by Sir W. Armstrong, the main topics of his speech being the mode of action of Giffard's injector, which has already been described in the INTELLECTUAL OBSERVER; the advantages of Siemen's regenerative furnace, and of Bessemer's process for making cast-steel. In our next we shall give abstracts of such of the more important discoveries brought forward in the different sections as have not been hitherto described in our pages.

NOTES AND MEMORANDA.

NOTE ON SATURN'S RINGS, BY MR. PROCTOR.—We have received the following from Mr. Richard Proctor:—"It is certainly not absolutely impossible that in some parts of the universe vapours may have a density greater than that of water—that is to say, some hundreds of times greater than that of the densest terrestrial vapours. By admitting the possible existence of such vapours near Saturn, we widen the field of speculation as to the nature of Saturn's rings; and if we further assume that the rings are not under the dominion of gravity, there is a still 'wider field for the admission of dissimilar theories.' The only positive (but far from conclusive) evidence I know of against the former view, is the circumstance (proved by spectrum analysis) that Saturn's globe and rings are surrounded by an atmosphere whose constitution is very similar to that of our own atmosphere.* That terrestrial cloud reflects and intercepts light hardly proves that vaporous rings would do so; since cloud is not vapour, but formed by the condensation of aqueous vapour into minute, opaque, and (for the most part) hollow spherules of water. However, if we concede the possible existence of vapours of the density mentioned above, we may readily concede to them the power of reflecting or intercepting light. Your remarks on the dark ring remind me of a circumstance I had omitted to consider. Even if the reflective powers of a satellite and its primary were equal, the former would appear as a dusky spot in transiting the central parts of the latter's disc. For, by two well-known optical properties, the apparent illumination of any point of the disc of a satellite is equal to the real illumination, which varies as the cosine of the angle of incidence of the illuminating rays. Hence it may readily be shown that the mean illumination of the disc : the illumination of the centre of the disc (: : the content of a sphere : the content of its circumscribing cylinder)† : : 2 : 3. I may notice that, if the illumination of the dark ring could be determined, it would be very easy (assuming the truth of the satellite theory) to determine approximately the illumination of the part which crosses the ball. For instance, call the illumination of the central parts of the disc of Saturn, or of a satellite, 1; assume the illumination of the dark ring to be $\frac{1}{5}$, and, for simplicity, that there is no overlapping of the discs of satellites: required to compare the illumination of three small equal spaces—of the dark ring, of the dusky band across the ball (central part), and of the central part of Saturn's disc. Call these spaces respectively A, B, and C. The illumination of A, $\frac{1}{5}$, would be increased in the proportion of 3 to 2 if the whole disc of each satellite were as bright as the central part of the disc, or would be $\frac{3}{10}$. Thus the discs of satellites cover $\frac{3}{10}$ths of space A; and therefore of space B; and, further, $\frac{3}{10}$ths of the background of space B are in shadow, so that the mean illumination of the spotted background is $\frac{7}{10}$. Since $\frac{7}{10}$ths of this background, so illuminated, are visible, the light received from this part of space B is $\frac{49}{100}$; and since the discs of satellites occupy the remaining $\frac{3}{10}$ths of space B, and give the mean illumination $\frac{2}{3}$, the light received from this part of space B is $\frac{2}{10}$, or $\frac{20}{100}$; hence the total amount of light from space B is $\frac{69}{100}$. Thus the illumination of A : the illumination of B : the illumination of C : : $\frac{1}{5}$: $\frac{69}{100}$: 1, or : : 20 : 69 : 100. By assuming different values for the illumination of the dark ring these proportions can be varied. It may be noticed that, if we assume the illumination of A to be $\frac{4}{9}$, we obtain for the illumination of B its least possible value—viz., $\frac{5}{9}$."

84TH PLANET.—Dr. R. Luther, of Bilk, discovered a new planet on the 25th of August. Its mean position for 1865 is given by him in *Astronomische Nachrichten*, R.A. 324° 29′ 34″·4. S.D. 14° 17′ 49″·4. It is the size of a 10th magnitude star, and has been named Clio.

A FUNGUS IN IVORY AND BONE.—Professor Wedl found, on examining some sections of teeth that had been macerated for a few days in water, that they were

* *Philosophical Transactions*, 1864, p. 423.

† The parenthesis is introduced as suggesting a simple geometrical proof of the proportion in question.

attacked by fungus cells resembling mushroom spores. They perforate the cement and the ivory, but not the enamel. They live at the expense of the organic matter of the teeth, which they do not attack till after death. Their action is noticed in fossil teeth. Eberth and Kölliker appear to have previously made similar observations.—*Archives des Sciences. Sibzungsher der Wiener akad.*

THE DRY FOG OF JULY, 1863.—In 1783 a dry fog covered the greater part of Europe, and was considered one of the effects of the great volcanic eruption of that year. The dry fog of July, 1863, was specially noticed in Switzerland. On the 14th it began in the morning at Morges, and increased during the day. The mountains of Savoy could scarcely be seen, and at half-past six the sun scarcely projected any shadow, and none at 7·15. At night only large zenith stars could be distinguished. These effects lasted for several days, gradually diminishing. The Italian volcanoes were in action at the time.—*Archives des Sciences.*

THE GROWTH OF THE MISTLETOE.—M. Joseph Boehm states as the result of examinations and experiments, that "the mistletoe has precisely the same relation to its nutritive plant as a twig to its parent branch, or a graft to the stock.—*Bericht der Akad der Wiss in Wien. Annals of Natural History.*

REASONABLE CONDUCT OF A SPIDER.—M. Barthet states in *Cosmos* that he saw at Malta a scorpion caught in a spider's net. The spider immediately attacked the scorpion, but on discovering the character of his opponent, retreated hastily, and reappeared *under* his net, through which he could safely renew the combat. M. Barthet returned to the place a few days later, and found the scorpion dead and the spider disappeared.

ACTIVE PRINCIPLE OF CALABAR BEAN.—Dr. Vee obtains from the bean an alkaloid which he calls *eserine*, "eser" being the native name of the bean. He macerates the bean in alcohol, evaporates the fluid, rubs up the residue with a little tartaric acid, which he removes with water, supersaturates the solution with bicarbonate of potash, agitates with ether, which takes up the eserine, and deposits it on evaporation. Re-dissolved in ether, and allowed to evaporate spontaneously, it forms rhombic lamellar crystals. A dilute solution of eserine exhibits the poisonous properties of the Calabar bean. A student tried the effects of this substance on his own person. About half-past nine in the morning he took one centigramme of eserine in solution (about 3-20ths of a grain). It had no immediate effect, but as he was walking across the Place de la Concorde he felt a great heaviness in his head. He read as he walked, but soon lost power of distinguishing the letters, suffered from nausea and extreme weakness, without fever. With difficulty he reached the Tuileries gardens, having frequently to take hold of the trees, on account of the state of his sight. About half-past ten he had an attack of vomiting, after which he was able to sit down on a bench. He could not distinguish persons who passed him, but he saw the colours of objects at a greater distance. This condition lasted till half-past eleven, and it was not till an hour later that he was able to reach home, when he looked at himself in a glass, and found the pupils of his eyes scarcely perceptible. By one o'clock all the symptoms of poisoning disappeared.—*Cosmos.*

PRESERVING ELMS FROM INSECTS.—M. Eugene Robert, being directed by the local administration to stop if possible the ravages of the *Scolytus destructor* amongst the elms of the Boulevard d'Enfer, had the old bark lightly planed, and then caused the fresh surface to be impregnated with strong spirits of camphor rubbed in with a brush. M. Camille Schnaiter, writing in *Cosmos*, states that the insects have disappeared.

A FOSSIL ENGRAVING.—M. Lartet describes to the French Academy a plate of ivory dug up in Perigord, and having engraved upon it the head of a long-haired elephant.

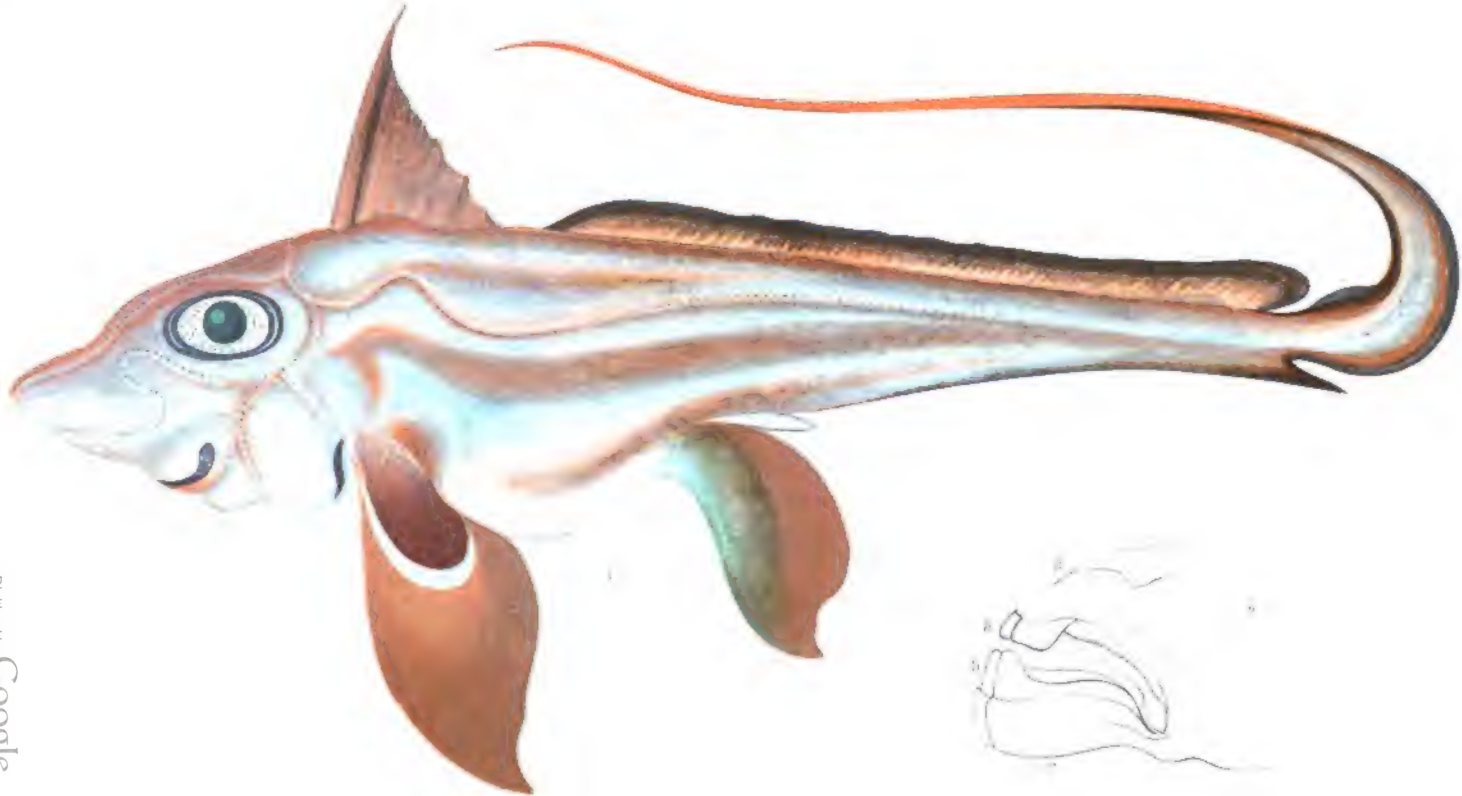
ANCIENT SCULPTURE ON REINDEER HORN.—M. de Vibraye has a paper in *Comptes Rendus* on some sculptured ivory and bone dug up at Augerie, on the right bank of the river Vézères, Dordogne, and especially describing the figure of an elephant's head carved in reindeer horn. The details do not coincide with

the existing species of elephant, but correspond with those of the mammoth. Taken in connection with the analogous discovery of M. Lartet, M. Vibraye thinks that no doubt can now exist that the men who sculptured these figures were contemporaneous with the mammoth.

Development of Striated Muscular Fibre.—Dr. Wilson Fox has a paper in the *Proceedings of the Royal Society*, in which he states that "the earliest form in which muscular tissue appears in the tadpole is an oval body containing one or more nuclei, and densely filled with pigmentary matter. This body has a well-defined outline, which induces the author to regard it as a cell, though he has not succeeded in isolating any distinct membrane. Such bodies increase in length with or without multiplication of their nuclei, and after a short period a portion of their structure loses in great part its pigment, and exhibits a striation sometimes transverse, sometimes longitudinal, or occasionally both conjointly, but there is no distinct line of demarcation at this stage between the striated and non-striated portion of the cell contents, showing that the change takes place within the contents of the cell."

The Size of Star Discs.—It is a very general opinion amongst telescopists that Mr. Dawes spoke without due caution and limitation in affirming at the Astronomical Society that the size of star discs depended upon the aperture of a telescope *only;* and that Mr. Pritchard was over hasty in declaring his accordance with an opinion that absolutely denies the effect of aberrations, chromatic and spherical, in making the spurious discs look larger than in well-corrected instruments. Steinheil has noticed Mr. Dawes' contradiction of his statement that the focal length of an object-glass directly affected the size of the discs, the latter being smaller as the focal length assigned to any given aperture was diminished. In the *Astronomische Nachrichten*, Steinheil accepts this correction, and he explains the fact that his Leipzig 8-inch telescope does not separate stars which other instruments of the same size will divide, by ascribing it to the superior light of his own instrument. By augmenting the apparent brightness of a star, he says its disc is increased, and may be diminished by lessening its brilliance. Some of our readers who have large telescopes will be able to test this theory by adopting various modes of lessening the light. The late Admiral Smyth, acting, we believe, on a suggestion of Sir John Herschel, occasionally stopped out a portion of the centre of his object-glass. Mr. Knott of Woodcroft, Cuckfield, who has a very fine 7½ inch object-glass, and who is familiar with this plan, has just been kind enough at our request to make a special trial of its effect and let us know the result. He does not profess adhesion to Steinheil's theory, but on stopping out 2 inches in the centre of his object-glass he found that it cleared up the disks of that difficult object γ^2 Andromedæ, when powers of 360 to 791 gave a beautiful vision of two unequal disks crushed together with a dusky streak across the base of junction.

To Distinguish Linen from Cotton.—*Cosmos* states that Professor Böttger asserts that the mixture of cotton with linen may be detected by unravelling a piece of the tissue, both warp and weft, and plunging it into a weak solution of aniline and fuchsine. It should be taken out, and washed with plenty of water, and while moist, dipped in water containing a little ammonia, when the cotton threads will lose their colour, while the linen will remain bright rose red.



Chimæra Mediterranea

THE INTELLECTUAL OBSERVER.

NOVEMBER, 1865.

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BY RICHARD D[illegible]N, M.D.

(*With a Coloured Plate.*)

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FISHES OBSERVED AT NICE, 1865.—THE CHIMÆRA AND THE ALEPOCEPHALUS.

BY RICHARD DEAKIN, M.D.

(*With a Coloured Plate.*)

Couch, in his *History of the Fishes of the British Isles*, vol. i., p. 149, says of the *Chimère arctique*, Lacep., or *Chimæra monstrosa*, Linn., that "it is not the least remarkable portion of the history of this fish, that while its most chosen residence is in the depths of the Polar seas, it is also found in the Mediterranean, where it has been caught so frequently as to have received the familiar name of Cat from the fishermen of Nice. In explanation of this we can only suppose that in some former distribution of the temperature of our world, this fish inhabited other regions than those in which it is at present found; and that the extreme depths of the Mediterranean Sea continue to afford it all the requisite conveniences for life and propagation that are now also found, and more generally, in the more northern regions."

The species here referred to is occasionally caught at all periods of the year in the Bay of Nice, showing that in its deep marine valleys the fish finds a congenial place for its dwelling and propagation. It is called by Risso *Chimæra Mediterranea*, and it differs in so many particulars from the representation of the *C. arctiqua* in *Cuvier's Règne Animal*, as to appear to be a different species, so that the illustrations and description which I made in January last from fresh-caught specimens in the Bay of Nice may be useful to some of the readers of the Intellectual Observer.

The specimen selected of the *Chimæra Mediterranea*, Risso, Fig. 1, is of a medium size, and measures from the end of the snout to the end of the tail thirty inches, but it is not unfre-

quently taken twice that length. The *body* is somewhat compressed on the sides, and gradually tapers from the head to the end of the long cord-like tail. The *skin* is very soft, smooth, pliant, and mucous, its colour a warm glaucous grey, shaded along the back with dark brown, and on the sides with paler brown shadings of a warmer tint; the abdomen and under part white, and covered over with very small silvery scales, and reflecting in certain light a very bright glaucous hue, glistening like silver. The *head* is large, thick, sloping from the top of the eyes with a slight curve into a soft, obtuse, rounded snout, which is cleft at the end, and underneath it, and near the centre of the eye, is the rather small *mouth*. The jaws are furnished with bony plates in the place of teeth—the upper jaw has two, broad, rounded at the inner angle, and behind them are two large, broadly triangular plates which form the roof of the mouth; the lower jaw is also furnished with two somewhat triangular-shaped plates, the front angles elevated into rounded lobe-like teeth opposite the upper ones, the sides are extended along the edge of the jaw, and entirely lining it with a hard polished plate, which is strengthened with thickened, elevated rounded bands, thus rendering them much more powerful instruments for crushing the food. *Eyes* large, placed high on the head, prominent, of an oblong shape; the *iris* silvery white, dotted with green points; the *pupil* large, prominent, of a glaucous green colour. From the top of the eye the neck ascends to the first dorsal fin, and from this the back descends in nearly a straight line to the tail. The *first* dorsal fin is placed opposite the pectoral fin, is of a triangular shape, having in front a long, solid, triangular-pointed spine, the angle in front of which is rounded, obtuse, smooth, but the two other angles are sharp-edged, and finely toothed, the teeth pointed downward. The fin is membranous, a greyish brown colour, the margin waved and blackish; the lower portion is united to the *second dorsal* fin, which is narrow, of the same width throughout, and extends the whole length of the back to the root of the caudal, terminating in a rounded lobe; it is of a pale brown colour, with a black margin. The *caudal* fin is of the same colour as the dorsal, but narrower, and extends on both sides of the tail, gradually becoming narrower until it is lost in the long pointed cord-like tail, which, from its root to the end, is about as long as the rest of the body. The *anal* fin is at the root of the caudal, small, blackish, fleshy, extended into a narrow lobe. The *ventral* fins are broad, elliptical, arising on each side of the vent about the middle of the body, they are thick and fleshy at the base, becoming membranous towards the margin, and of a dark brown colour; from the inner margin close to the body each of these fins has an oblong,

white fleshy clasper divided into two lobes at the point. The *pectoral fins* are large, oblong, obtusely pointed, thick and fleshy, with a large reddish disc at the base; the rest of the fin is membranous, and of a brownish grey colour. At the base of each of these fins is a narrow, longish opening to the gills, which is single, and not several, as in the sharks. The *lateral line* is elevated, pale, with a darker line on each side. It arises from a little beyond the back of the eyes, is curved up towards the first dorsal fin, but soon descends again, and is then continued in a nearly straight line to the end of the second dorsal fin, where it is curved down to the lower edge of the caudal fin, where the lateral lines of each side are united together, and from this point it is continued as one line along the slender tail. From the commencement of the lateral line at the back of the eye two other branches start, one to the top of the head, which soon becomes divided into two, one branch going over the head to join the lateral line on the opposite side, the other runs along the top of the eye to the snout; the other branch from the back of the eye takes a downward direction along the lower edge of the orbit, and takes a zigzag course over the cheeks to the snout, and becomes joined to one which is carried down the front of the snout; other branches are sent off to the gill openings and each of the lips: along the whole course of these lines it has numerous small round openings, which appear to be the ducts for the distribution of a secreted mucous.

The common name of *chat* (cat), by which this fish is known by the fishermen at Nice, was given to it from the noise like the mewing of a cat which it makes when taken out of the water. The flesh is white, soft, and glutinous, and has not an agreeable flavour, so that it is not used as an article of food, but it is caught for the very large liver with which it is furnished, and the limpid oil which they extract from it, which they burn in their lamps, as it gives a very brilliant light. It, however, has a disagreeable odour—a quality which the fishermen do not appear to think very objectionable. It has the reputation, like the oil extracted from the liver of some other fishes, of being a valuable remedy in the cure of rheumatism, especially when rubbed over the swollen and painful joints.

Fig. 1 is a lateral view of the entire fish.

Fig. 2, part of the skull, showing, *a*, the upper teeth; *b*, the lower teeth; *c*, the lower jaw; *d*, the upper jaw and orbit.

Another species, which inhabits the deep marine valleys of the Mediterranean, is the *Alepocephalus*, Risso. Its generic characters are—*body* ovate oblong, compressed, covered with

ovate scales; *snout* rounded, advanced; *jaws* and palate with very fine acute teeth; *gape* large; *eyes* very large; *gill covers* with eight rays; *dorsal fin* opposite to the *anal,* and both placed near the tail. Only one species is known, which is the

A. rostratus, Risso, commonly called *Alepocephale à bec.* The *body* is twelve to fourteen inches long, of an ovate oblong shape, the sides compressed, covered with large ovate oblong thin scales, marked with fine circular lines of a violet blue colour, and each scale clouded towards the end with minute brownish black dots. The head is of a medium size, covered with a black, glossy, membranous-like skin, which is very thin, naked, entirely without scales, and extended over the gill-covers, and forming the brachial membrane; the *eyes* are very large, prominent; the *iris* black; the *pupil* somewhat glaucous. The *forehead* slopes from the top of the head, and is curved in front of the eyes, and is then extended into a projecting rounded snout; the *upper jaw* longest, furnished on the margin with a single row of fine sharp-pointed teeth, except at a notch in front, and within is another row of similar teeth, on the edge of the palate; and into the groove formed between these two rows the edge of the *lower jaw* fits in, which is also armed with a row of teeth similar to those in the upper jaw. The sides of the jaw are wide, and the point terminates in an obtuse bony protuberance. The *tongue* is free, smooth, and, like the palate, lined with black. The *nostrils* are two on each side, in front of the eyes, the one nearest the eye much larger than the one in front of it. The *gill-covers* are extremely thin, long, angular below, roundly lobed at the back; the *brachial membrane* loose, furnished with eight slender rays. The *neck* is flattened, with a somewhat prominent osselet running its whole length. The *lateral line* arises from the top of the gill-covers, behind which it is curved down to near the middle of the body, and then continued in a straight line to the tail; it is formed of a series of short tubes on the middle of the scales along its course; and there are some of these tubes arranged beneath the lower jaw; they appear to be ducts for the conveyance and distribution of a mucous secretion over the surface of the body. The *fins* are of a blackish colour, covered at the base with scales; the *dorsal* is fixed far back, near to the tail, and has fourteen rays; and opposite to it, on the under side, is the *anal;* it is similar in shape to the dorsal, but extends rather nearer to the tail, and has fifteen rays. The *ventrals* are placed in the centre of the body, and have eight rays; the *pectorals* are near the edge of the gill-covers, and have eleven rays each; the *caudal,* which is large and strong, is somewhat half-moon shaped; it has thirty rays. The female, which resembles the male in its

general appearance, is full of brownish-coloured ova during the summer months.

The Chimæra and Alepocephalus are good examples of those fishes which inhabit the deeper parts of the sea—that is, from two to three thousand feet; and how much deeper than this any kind of vertebral fishes are capable of living is very doubtful. And of those fishes which are known to live in very deep water, it may be observed that their eyes are disproportionately large and prominent—an adaptation of the organs of sight made by the all-wise Creator, by which the creatures are enabled more effectually to collect the diminished power of the rays of light at so great a depth of water, and are thus made capable of seeking their food and the enjoyment of life in their appointed abode. The skin, too, is thin and soft, and the scales loosely adherent, and the colours with which they are adorned are far less brilliant, more clouded, and their marking is not as distinctly defined as in those fishes which inhabit the shallower parts of the ocean, where the sea-weeds and corals, etc., abound, and where the power of the sun's illuminating rays are more potent, as is found to be the case in the Julia, the Labias, the Crenila bras, etc. The flesh of these deep-sea fishes is also softer, more gelatinous, and much sooner decomposes after death, than that of most other fishes.

The difference in the structure of these two fishes is very remarkable, and worthy the attentive consideration of the student of nature's works. The Chimæra, with its obtuse, fleshy snout, has its mouth placed underneath and behind it, and the slit-like opening to the gills before the pectoral fins allies it to the shark tribe, and its peculiar shaped head, bony, plate-like teeth and palate, shows that its food is that of some hard substance, or it would not be furnished with such powerful organs to crush it; and we find that it lives on crustaceous or molluscous animals, that have hard shells or bony coverings. The Alepocephalus has the ordinary form of abdominal fishes, and its mouth is furnished with rows of small, fine, slender, pointed teeth, showing that its food is of a soft substance, and which is not protected by any hard or bony covering.

THE WINDS.

BY A. S. HERSCHEL, B.A.

In a recent pamphlet, by Dr. Klein, on Foretelling the Weather, translated from the Dutch by Dr. Adriani, the atmosphere is described as being the means of keeping up upon the earth the salutary movement which it constantly requires. The office of the atmosphere by which the various forms of life upon the earth are supported, and conveyed to distant places to renovate its surface, is performed in part by a steady process of distillation, and in part by the perpetual agitation of the winds. The constant round of functions it fulfils will accordingly well repay attention to examine very closely in detail. For present purposes the atmosphere must first be regarded as a vast cryophorus, or as an immense distilling apparatus, having its boiler on the surface of the earth, and its condenser at the summit of the atmosphere. The vertical process of evaporation and condensation into rain can then be fitly described, which everywhere takes place in a tranquil atmosphere, in the absence of the horizontal currents of the winds.

Over the greater part of the equator, and especially on the ocean, where the air is calm, clouds are seen to gather in the morning, which collect before the evening, and break with heavy showers of rain. A fall of two or three inches of rain in as many hours is no uncommon occurrence in those regions; whence the name of "cloud-ring" is applied to these parts of the equator. Wherever under the full heat of the sun the wind subsides, a cloudy season similar to that at the equator commences. In certain places between the tropics, the regular winds are thus suspended when the sun approaches the zenith of the latitude, and a season of "tropical rains," as they are called, immediately sets in. This happens in April on the Orinoco, in May or June at Sierra Leone and Calcutta; falling later in the year at each place according to its distance from the line. On the opposite side of the equator the island of Mauritius, situated on the outer border of the trades, is visited in February by heavy rains; which is also there the hottest season of the year. The rice fields in the valley of the Ticino, in Lombardy, owe their fertility to the tropical rains which fall in summer on its sheltered plains. A part of the European and Asiatic continents, and a part of central America, are described in a less marked degree as districts of "summer rains." This remark is illustrated by the fact, familiar to readers of the Intellectual Observer, that at the mouth of the Danube, in the summer of last year, the rains were noticed to be "quite tropical" in their extent and character.

Supposing, now, the boiler of the cryophorus to be at the equator, and its condenser at the poles, a distribution of rain in a horizontal direction from the equator would take place. But the winds alternately carry moisture outwards from the equator, and act as condensers returning from the poles; and the process of lateral condensation is also modified by elevated mountain ridges and irregularities of the land. Upon the south-west coasts of Europe, autumn rains are abundant, occurring with the season of the south-west wind. The effect of mountain ranges in arresting moisture, is illustrated by the enormous quantities of rain which fall at Coimbra, Borrowdale, and Bergen, on the coast: whilst Madrid, surrounded by high mountains on the table-land of Castile, has a rainfall of only ten inches in the year. At Lyndon, in the centre of England, the rainfall is below the average. Only flower seeds can be cultivated in some parts of the British Islands, on account of the deficiency of moisture; but at Seathwaite in Cumberland, at Toronsay in the Isle of Mull, and at Portree in the Isle of Skye, the fall of rain is more than 100 inches annually. Other examples, to illustrate the effect of mountain ranges in precipitating the moisture of the wind, will be borrowed from tropical climates, in describing the winds of those climates, called monsoons.

In the highest regions of the atmosphere, where condensation constantly takes place, moisture is deposited in the solid form, and accumulates from year to year, as snow, on mountain tops, even at the hottest parts of the equator. Large masses detaching themselves from its sides, rush down the steeps in avalanches; but water melted from the surface by the sun, converts a large portion of the interior into ice. Glaciers are thus formed, whose ponderous masses slowly descend the ravines, until they melt away below in torrents that water innumerable valleys. Above the height where the mean temperature of summer is the same as the freezing-point of water, there is a perpetual surface of fresh fallen snow. Below this point, the glaciers and mountain slopes, in summer, are free from snow. The level in question is called the "snow-line," or level of perpetual snow.

The following table of the measured height of the snow-line in widely different latitudes, from a list of places contained in Humboldt's work on *Central Asia*, enables us to calculate the decrement of temperature, in ascending, from the mean heat of summer on the plains, to a temperature of 32° (F.) at the height of perpetual snow. The corresponding decrements for equal elevations, determined by Mr. Glaisher in his recent balloon experiments, when the sky was clear, are next entered in the table for comparison.

Table V.—Height of the snow-line above the sea, and mean temperature of summer in the plains, from Humboldt's *Central Asia.*

Place.	Mean summer temperature at sea level.	Measured height of the snow-line above the sea.	Decrease of temperature.	The same (from Mr. Glaisher's balloon experiments).	Difference.
	° (Fah.)	feet	° (Fah.)	° (Fah.)	° (Fah.)
Quito	83·5	15,900	51·5	45·8	—5·7
Himalayas (S. Side)	73·4	13,056	46·4	40·2	—6·2
Mt. Ararat	78·1	14,250	46·1	42·5	—3·6
The Alps	65·1	8,937	33·1	31·0	—2·1
Kamschatka	54·7	5,280	22·7	21·6	—1·1
Isle Mageröe (N. Cape)	44·5	2,286	12·5	11·9	—0·6

The regular progression noticed in the last column of differences, appears to show that the heat of summer on the plains fairly determines the elevation of the snow-line, but the decrement of temperature with the height near the equator appears to be more rapid than that found in the experiments of Mr. Glaisher.

No better description can be given of the ventilating system of the atmosphere, than that which is contained in Sir John Herschel's work on Meteorology, from whom we borrow the following exposition of the process (*Meteorology,* p. 54):—

"In the intertropical seas a steady and copious evaporation is continually going on. The vapour, carrying with it air, is thrown up beyond the levels of equilibrium, where it flows over, and spreads itself out over the upper regions of higher latitudes. Air also, when heated over large tracts, acts by increased elasticity to upheave the superincumbent strata, and by bulging them upwards to destroy their equilibrium, and cause the upper atmosphere to flow over on less heated regions. It is impossible to separate these two dynamical effects. The immediate effect of the application of heat to any region, is to generate an ascensional movement in the incumbent atmosphere: a bodily overflowing of its material above, and a relief of barometric pressure below."

In the Atlantic Ocean, from the equator to 5° N. latitude, the atmospheric pressure is 29·92 inches. From 30° to 35° N. latitude it is 30·17 inches, and from 25° to 30° S. latitude it is 30·11 inches; making the relief of barometric pressure 0·22, or

nearly a quarter of an inch between the equator and the tropics in this part of the ocean.

A further account of the origin and nature of the great ventilating system is given by Sir John Herschel in the same work from which the former paragraph was borrowed (*Meteorology*, p. 56):—

"The air of the cooler surrounding region not being so relieved (by overflow), but rather the contrary, owing to the increase of weight poured on it from above, will be driven in by the difference of hydrostatic pressure so arising; and thus originate two distinct winds, an upward one, setting *outward* from the heated region, a lower, *inward*. If the region heated be a whole zone of the globe, such as the generally heated intertropical region, these currents will assume the character of two sheets of air setting inwards on both sides below, uniting and flowing vertically upwards along the medial line, and again separating aloft, and taking on a reversed movement."

The upper and lower currents, from what was said in the former article on their stratiform character and horizontal extension, remain distinct, and travel separately over a tract of many degrees from the equator. The direction of the upper current may be inferred from the following remarks of Redfield, whose opinion on the subject of aërial currents must always be regarded as of the greatest value:—

"We learn from Humboldt that in the great eruption of Jorullo, a volcano of southern Mexico which is 2100 feet above the sea, the roofs of the houses in Queretano, more than 950 miles N., 37° E. from the volcano, were covered with the volcanic dust. In January, 1835, an eruption took place in the volcano of Cosequina, on the Pacific coast of Central America, having an elevation of 3800 feet above the sea, the ashes from which fell on the island of Jamaica, distant 730 miles N., 60° E. from the volcano. The ashes of the volcano of St. Vincent fell at Barbadoes in 1812, a distance of 120 miles nearly due east from the volcano."

The direction of the upper current is therefore very oblique to the meridian, and directed from south-west towards north-east. The cause of this deviation now remains to be explained.

Were the earth at rest, and did the sun actually revolve about it as it appears to do, the main currents of the air produced at the equator would everywhere follow the course of the meridians, and no deviation would occur. But an appeal to experiment will readily show that a deviation of exactly the kind observed is really caused by the rotation of the earth.

Suppose a whitened globe to be suspended by one of its poles; in such a manner that it can be turned from east to west,

to represent the daily revolution of the earth. A circular rim pierced with holes is fastened to the globe, about its upper pole; and a few streams of ink are allowed to run from these upon its surface, whilst the globe revolves. In a few seconds the globe can be brought to rest, and the direction of the streams can be examined. Each stream presents a curvilinear line; in general very oblique to the meridians, but at its centre transverse to the equator, to which its upper and lower branches are also symmetrical, and turned towards the east in the manner of a Greek letter ϵ. This simple experiment may very well be taken to represent the real course of nature. The streams in the upper half of the globe represent the trade winds, which blow from the north-east in the northern hemisphere, and from the south-east in the southern hemisphere of the globe. At the equator they are exactly opposed to one another, and blow due north and south, where the belt of the "variables" is formed, as they are called, because they are mixed at this place with westerly monsoons. The streams in the lower half of the globe represent the anti-trade winds. These return upon the same course as the trade winds, but in the opposite direction to the point whence those set out, and blow from south-west in the northern hemisphere, and from north-west in the southern hemisphere of the earth.

The anti-trade wind blows in summer upon the top of the Peak of Teneriffe, while the trade wind sweeps its foot. In winter the anti-trade wind reaches the ground about the latitude of the Canary Isles, and in its contest with the trade winds forms the "horse-latitudes" of the ocean, with rains as copious as those at the equatorial calms. From this point to the latitude of 50°, and upwards, the anti-trade is the prevailing wind of the Atlantic Ocean, almost as surely as the trades between the tropics. These winds are only constant on the open oceans of the globe, for a reason that is easily explained. In the neighbourhood of continents they are replaced by winds of a different character, called monsoons.

The constant overflow, and demand of air at the equator produces an equally regular supply, flowing north and south towards the line. Obedient to the impulse of the wind, a drift of surface-water inwards is produced, and a line of greatest heat is thus established at the equator, whose position hardly varies with the seasons. In this way the trade and anti-trade winds acquire a cast, or set by which the uniformity of their circulation is secured.

Coming from latitudes where the velocity of rotation of the earth's surface is less swift, light air currents quickly take up the velocity of rotation of the circles of latitude over which they pass. It is different with the surface drift of water.

This, from its greater weight, preserves a relatively sluggish motion up to the equator. A "main equatorial current" is thus produced in the Atlantic Ocean, flowing with a velocity of from two to four miles an hour towards the west (with various branches towards the north and south), and finally losing itself in the Carribean Sea. The level of the Gulf of Mexico is thereby raised, and a stream of water, without a parallel for magnitude and velocity, flows from this gulf through the narrow Straits of Florida. Where it enters the Atlantic Ocean, the Gulf Stream, as it is called, is thirty-two miles in width, two or three hundred fathoms deep, and its average velocity is about five miles an hour. Its temperature is 83° Fahrenheit.

Off Cape Hatteras the Gulf Stream leaves the American coast; and spreading itself over the Atlantic Ocean, in two or three months it attains the longitude of the Azores. Beyond this point, at all seasons in ordinary years, and in every direction in the great ocean-space comprised between the Azores and the coasts of Europe and Western Africa, the sea is of the ordinary temperature for its latitude, and the warm water of the Gulf Stream is not found. But Major Rennell has shown that on two occasions—namely, in 1776, as observed by Dr. Franklin, and in the winter of 1821-2,— the warm water which characterizes the Gulf Stream was found to extend across this great expanse of ocean. In November and December, 1822, and January, 1822, the weather in the south of England and in France was characterized as most extraordinarily hot, damp, stormy, and oppressive. The gales from W. and S.W. were almost without intermission, the fall of rain was excessive, and the barometer was lower than it had ever been known for thirty-five years before. If an unusual velocity at its outset, or a greater height than usual of the water at the head of the stream, causes these invasions of the Gulf Stream, these might be recognized by proper attention. As they must precede by many weeks the arrival of the warm water on the coasts of Europe (more than 3000 miles from its source), in this manner the climatic effects arising from this stream, and the occurrence of such unusual seasons upon our coasts as that of 1821-2, might probably be anticipated.

On land, where no such movement as that upon the surface of the ocean can exist, the focus of greatest heat follows the motion of the sun once in every year to either tropic. The annually alternating winds that arise in this manner are called "monsoons."

Table VI.—Mean Annual oscillation of the barometer at Greenwich, above and below par height, for nineteen years (1840—58).

	in.		in.		in.
Jan.	— 0·031	May	— 0·029	Sep.	+ 0·056
Feb.	+ 0·012	June	+ 0·017	Oct.	— 0·077
Mar.	+ 0·060	July	+ 0·013	Nov.	— 0·037
April	— 0·030	Aug.	+ 0·010	Dec.	+ 0·036

The mean height of the barometer at Greenwich, from 1840 to 1858, was 29·782 inches, or reduced to the level of the sea, 29·953 inches. The mean annual oscillation above and below this height was very small, and irregularly distributed in the year. A settled condition of the barometer is not only observed in Western Europe and Africa, but also over the greater part of the Mediterranean Sea. Over the whole continent of Asia, in the east of Europe, in Arabia, Nubia, and part of Central Africa, a very remarkable depression of the barometer takes place in summer. A lack of aqueous vapour in summer, to supply the sudden overflow of heated air, evidently occasions the barometric depression over this wide area, which embraces the most arid plains and the highest table-land of the world. At the same time, the barometer in the southern hemisphere is high (although the pressure of aqueous vapour is least), showing that air is actually transported to that quarter in a bodily shape. In winter the barometer in Asia is high, whilst the barometer in the southern hemisphere is low, showing that an influx takes place in the opposite direction. These oscillations of the barometer, lately shown to exist by Dové of Berlin, explain the origin of the monsoons upon the Indian Ocean.

In the same manner that a barometrical depression, and consequent circulation of the air are permanently produced upon the ocean by the sun's heat, an annual overflow of air from the continent of Asia takes place in summer, accompanied by currents flowing inward below, outward above, to and from the heated region as a centre. In winter, when the barometer is low over the southern continents of Africa and Australia, and high over Asia, the conditions are reversed, and the currents then flow in an opposite direction.

From the great stretch of land (nearly a quarter of the northern tropic) by which the Indian Ocean is barricaded on the north, the impulse of the Asiatic monsoons is alternately due north and south. Owing, however, to the diurnal rotation of the earth they deviate from this direction towards the east and west—like the trade and anti-trade winds—and are called from this circumstance the north-east and south-west monsoons.

The south-west monsoon makes its first appearance in April on the coast of Malabar: with a rainfall of 80 to 170 inches,

between April and October, upon the range of the West Ghauts, and thick weather extending to fifty miles from shore. At sea it is a rainless wind. This monsoon stretches across the whole Northern Indian Ocean, from Africa to the Malay Peninsula, originating 3° to 4° north of the line, at the northern edge of the "Doldrums," or equatorial calms, which separate it by a belt of 10° or 12° from the south-east trade. The south-west monsoon sweeps the Arabian Sea, and traverses the rainless district of the Indus. It also enters the Bay of Bengal, and produces a heavy fall of rain upon the mountainous coast of Aracan. Farther east it scours the China Sea to its limit in the Philippine Islands, the outposts of the Pacific. In this extensive range the period of its commencement at different places is April, May, or June, according to their remoteness from the equator. Probably no greater rains are caused by this monsoon, or indeed by any other wind on the earth, than those which fall at Cherra-Ponjee in the north-east hills of India, where 592 inches of rain are said to be collected annually. Two or three hundred inches are no uncommon quantity in other parts of the Himalayan range, during the season of this monsoon. The general aridity of Central Asia is thus in a striking manner accounted for.

The north-east monsoon commences in October, and occupies until April the whole of the tract vacated by the opposite monsoon. A monthly fall of fifteen to twenty inches of rain, with this wind, on the coast of Coromandel, appears to be caused by its condensing action on the upper current, when upheaved by the elevations of the coast. Like the other monsoon, it is itself a rainless wind.

The north-east monsoon crosses the equator at two points, one near the channel of Mozambique, which it enters; the other towards the Java Seas, which it traverses as far as New Guinea and Timor. In these lesser districts the south-east trade wind is replaced by a north-west monsoon (corresponding to the anti-trade wind of that hemisphere), occasioned by barometric depressions over the heated continents of South Africa and New South Wales. On the western coast of Mexico, also, the north-east trade in summer is similarly reversed by a south-west monsoon; but the most remarkable monsoons are those of the equator on either side of the great continent of Africa. These two monsoons are westerly, and occupy what is commonly called the calm belt of the equator. They fall at opposite seasons of the year. The first, or "Westerly Line Monsoon," occupies the Atlantic side from July to October. The other, called the "Winter Monsoon," occurs in the "Doldrums" of the Indian Ocean, and occupies the remaining season of the year. In the words of Maury, "these

winds are a study, and suggestive of marked peculiarities in the climatology of equatorial Africa."

The trade winds are the permanent, monsoons are the annual, and land and sea breezes are the diurnal features of the general system of the winds. The last are caused by the daily depression of the barometer, which is most conspicuous at the equator. Humboldt, when at Cumana in 1799, affirmed that the hour of the day might be known correctly within fifteen minutes, by the rise and fall of the quicksilver in his barometer, which amounted to nearly the tenth part of an inch daily. In other latitudes, the oscillation, although easily traced, is smaller, and concealed by greater irregular movements of the mercurial column. The following table contains the average value of this oscillation, from bi-hourly observations at Greenwich for five years, 1841-45.

TABLE VII.—Mean Diurnal oscillation of the barometer at Greenwich, above and below mean height of the barometer, for five years (1841-45) :—

	In.		In.		In.
1 h. a.m.	— 0·002	9 h. a.m.	+ 0·009	5 h. p.m.	— 0·008
3 h. „	— 0·010	11 h. „	+ 0·011	7 h. „	— 0·000
5 h. „	— 0·012	1 h. p.m.	+ 0·001	9 h. „	+ 0·009
7 h. „	— 0·003	3 h. „	— 0·007	11 h. „	+ 0·009

The course of the numbers shows that the barometer stands higher by day than at night, owing to the generation of aqueous vapour. Its lowest minimum is reached about the coldest time in the morning, when the quantity of aqueous vapour is least. Another minimum occurs about the hottest hour of the day, when the heat of the sun causes a portion of the air to flow off from the top of the atmosphere. This minimum is less considerable than the great minimum observed at night.

The existence and character of this oscillation were known from the earliest use of the barometer, and are everywhere the same, wherever the alternation of day and night occurs. The extent and nature of the annual oscillation, on the other hand, depends upon local circumstances, particularly on the distribution of land and sea. For other and larger oscillations which return at stated periods no cause whatever can be assigned. It is observed, for example, that about the middle of November a wave of high barometric pressure passes over England, and another about the 25th of December. In this interval the barometer reaches a very low point about the 28th of November. To trace the motion of these atmospheric waves, the ocean has been divided into squares, each numbering ten degrees of latitude and longitude. A permanent depression of the barometer to the extent of fully an inch was

discovered by Sir James C. Ross, about the longitude of Greenwich, upon the confines of the Antarctic Sea. Another region of great permanent depression, near the Sea of Ochotzk, is known to exist at a diametrically opposite point upon the earth. If these observations should be confirmed, there can be little doubt that a cyclonic tendency of the wind round these regions must exist as a permanent feature of atmospheric circulation. May not these two regions of depression be the true Atmospheric Poles of the world; and may not the vortices which they appear to indicate furnish an answer to the question, "What becomes of the anti-trade currents of the air returned to polar regions from the equator?"

The velocity and direction of wind may be registered either in words or in a scale of figures, velocities, or pressures, as in the following table:—

TABLE VIII.—Wind-scales, or scales of the force of wind.

General term.	Land scale.	Sea scale.	Velocity. Miles per hour.	Pressure. lbs. on one sq. ft.
Calm	0	0	0	0
Light	1	3	10	$\frac{1}{2}$
Moderate . . .	2	5	32	5
Fresh	3	7	45	10
Strong	4	8	65	21
Heavy	5	10	72	26
Violent	6	12	80	32

Instruments for recording the force and direction of wind are called anemometers (*ἄνεμος, wind; μέτρον, a measure*). In Robinson's anemometer the distance run over by the wind is shown by four hollow cups attached to multiplying wheels, whence the number of revolutions can be read off upon a dial. A simple calculation then gives the velocity of the wind. The pressure of the wind on a plate of one square foot is proportional to the square of the velocity. It is recorded by means of springs, in Osler's anemometer, upon a moving sheet of paper, whilst a large vane records on the same sheet the direction of the wind. This instrument, by an ingenious contrivance, records automatically upon the same sheet of paper the depth of rainfall for any time. It has been erected at Plymouth, Greenwich, and Birmingham, as well as at Halifax and the Bermudas on the Atlantic, to register the force and direction of the wind.

On the average of twenty years at Greenwich, thirty-three days in every year are calm, when no pressures greater than ¼lb. are recorded. On thirty-two days the wind is above moderate, and the pressures exceed 5 lb. The remaining three hundred days of the year are occupied by moderate or gentle winds. Of these gentle winds the largest share falls to the summer months, in each of which the occurrence of a fresh wind is an even chance; but *not one single January* without fresh wind has occurred for twenty years. Strong and moderate winds alike are far most frequent from south-west, where the wind lies for about a third part of the whole year (119 days). North-east is the next most frequent point, and from E., S.E., and N.W., the winds are the rarest of the dial.

A change of the wind from S.W. to N.E. produces nearly as great an alteration of temperature and moisture in the air as a change from day to night. The weight and density of the air are at the same time greatly increased, and the barometer (whose other oscillations are extremely small) becomes a valuable index of the reversed conditions of the weather. Professor Dové has shown that the change of wind from one of these directions to the other is subject to a curious law arising from the rotation of the earth. No law in meteorology is more easily verified, or better stands the test of daily observations than this, which is called Dové's "Law of gyration of the Wind."

Suppose a north wind to arise, by a body of air commencing to move towards the equator; in a short time it will become north-*east* in the same manner as if it formed a portion of the constant trades. Should the indraught be replaced by an impulse outwards from the equator, the northerly element of motion is destroyed, and that from the east alone remains. The wind therefore veers towards the east and south, and at length becomes south-*west* in the same manner as if it formed a portion of the constant *anti*-trade. Should an indraught towards the equator once more return, the southerly element of motion is destroyed, and that from the west alone remains. The wind then veers towards the west and north to the point from which it originally set out. At every alternate impulse north and south, the wind veers half round the dial *in the same direction as the sun.* In the southern hemisphere the same mode of reasoning leads to the same conclusion, or, in other words, in both hemispheres, the wind, in its ordinary changes, veers round the dial in the same direction as the sun. When wind shifts round the dial in an opposite or retrograde direction, it is said to "back."

In this manner the vane of Osler's anemometer at Greenwich, in twenty years, has performed two hundred and forty-

eight more complete revolutions in one direction than it has in the other.

Enough has been said in this article to explain, in a general manner, the nature and office of the winds. A few words on premonitory signs will show by what appearances, and to what extent (apart from instruments), their arrival may often be predicted.

South-west gales reach the British Isles from warm and moist regions of the Atlantic, in the direction of the Azores. They shelve upwards by their levity as they approach, and the phases of the advancing current can be traced by the growing streaks of cirrus in the upper air. The wind, at first in the north-east, veers very slowly through the east towards the south, and the blue curtain of the sky appears lined with bands of cirro-stratus cloud, stretching from horizon to horizon across the direction of the upper wind. Halos of every form, and a narrow border of light surrounding the moon, are a symptom of this condition of the wind. If these signs are remarkable for brightness or extent, and the clouds thicken, they take the form of *cirro-cumulus*, or a "mackerel-backed" sky, and are followed by severe falls of rain, hail, or snow, on the arrival of the wind.

North-east gales arrive upon the British coasts from colder climates, and from their greater gravity creep along the ground. Driving off the warmer air, they at first create dense clouds, or, contending with a southerly current, lightning, rain, and snow are produced, and the wind, at first south-west, veers rapidly through west towards the north. When the northerly current is established, fine weather reappears. Coronas, or highly-coloured circles round the moon in ragged clouds that scud before a north-west wind, indicate a liability of this wind to "back," and for the same order to begin again.

Lightning is always caused by the sudden condensation of vapour into rain; and the more rapid this process, the more severe is the lightning. Hail occurs in sultry weather, when aqueous vapour reaches a great height, and becomes entangled in currents of low temperature. That these storms in the upper air are often of a violent character may be inferred from what is related by Olmsted in America, Buist at Bombay, and Neumayer at Melbourne, in South Australia, that hailstones as large as pigeon's eggs are of annual occurrence.

With hail, as with rain, the tension of electricity on the surface increases in the exact ratio of the diameter of the drop. The present year was distinguished by two instances of hailstones of extraordinary dimensions, accompanied by very destructive lightning, at Liverpool and at Birmingham, on the 21st of May and 8th of July. One of the greatest falls of hail, since the

extensive hailstorm which passed over France and the Netherlands on the 13th of July, 1788, took place in the valley of the Scheldt on the evening of the 7th of May, and was followed by a fearfully destructive storm of lightning and thunder on the night of the following day over France and the Channel Islands, and over the southern coasts of England. The hailstones in this instance formed a perfect glacier, and canals in the Netherlands could be crossed dry-foot.

The aurora borealis, or northern lights, are occasionally supposed to have a distinct connection with the weather; but it has been shown (contrary to this hypothesis) by Professor Loomis that every display of aurora in the north is accompanied by a simultaneous display of aurora in the southern hemisphere of the earth, which is contrary to the supposition. Fiery meteors, also, are called "wind-headings" by the fishermen upon our coasts. That these are of astronomical character there cannot be a doubt, from their annual appearance in unusual numbers on the 9th—11th of August, and again on the 12th—14th of November.

For those astro-meteorologists who trace the signs of the weather in the stars, an example of coincidence without connection is presented in the following table of the dates when remarkable displays of the November meteors have been observed, compared with those in which, according to Arago, severe winters were felt upon the Mediterranean coasts of Europe.

TABLE IX.—Dates of the November shower of meteors, and of severe winters, arranged for comparison in groups:—

1. Dates of meteors.

A.D. 902, 1002, 1101, 1202, 1602, 1698, 1799	(Mean - - - 1)
A.D. 931, 1533, 1832, 1833	(Mean - - 32)
A.D. 1366	(Mean - - 66)

2. Dates of severe winters.

A.D. 1290, 1301, 1302, 1517, 1594, 1709, 1812	(Mean - - - 4)
A.D. 1133, 1236, 1336, 1544, 1839	(Mean - - 37)
A.D. 860, 1274, 1463, 1468, 1570, 1756 . .	(Mean - - 65)

A period of the third part of a century appears to represent the return of the meteoric shower with precision. Allowing for meteorological contingencies, the same period appears to exist in the return of severe frosts. The coincidence is apparently complete; only the connection is by no means evident.

The present time may, accordingly, be regarded with probable foundation as a season of severe winters in the South of Europe. The extraordinary shower of meteors may be ex-

pected with greater certainty to return in full splendour in the present year, and the next, when observers will probably be repaid by watching for its appearance from midnight until daybreak on the morning of the second Monday in November, and again on the morning of the 13th of November, 1866.

A BRIEF HISTORY OF A MARINE TANK.

BY SHIRLEY HIBBERD.

In the "Brief History of a River Tank," published in February last (Intellectual Observer, vii., p. 38), I stated, as explicitly as I could, the principal features and advantages of the natural system of tank management, in order to present an illustration in the case of a tank so managed, and which was then, and still is, in the most perfect condition, and a familiar object with a large circle of friends. In my *sanctum* I have a marine tank which is fitted and managed on the same plan, and I propose to offer a few observations on this and some other vessels which have been used for marine collections.

When engaged in the experiments which were the foundation of my first written essays on the aquarium twelve years ago, and subsequently of the *Book of the Aquarium*, and some scattered papers in periodicals, the grand difficulty was to determine an exact and self-sustaining balance between the various forces and influences that an aquarium brings into play. Every failure then occurring was the result of attempting too much, and of absolutely doing too much; and looking back through all the experiences since acquired, I can say without a blush that the original notions entertained by aquarium practitioners were supremely ridiculous. Shall I ever forget the waste of precious time, and strength, and money in attempts to domesticate the larger forms of marine algæ? Shall I ever forget the sanguine wishes that were entertained of the successful cultivation of *Padina pavonia, Laminaria phyllitidis, Delesseria sanguinea, Ptilota plumosa,* and the lovely *Griffithsia setacea,* and how those hopes only faded out when years of watchfulness and wasted energy made it but too evident that it was easier to dream than to do? No, I shall never forget that the one great lesson that had to be learnt, and which needs to be repeated here, is that small quantities of sea water enclosed in vessels in dwelling-houses, are too peculiarly circumstanced to be made representative of Neptune's watery

kingdom, but they may be made representative of rockpools and recesses. We may treat them as spoonfuls of water, and achieve such success as spoonfuls admit of; but we must not suppose we have the sea at our command, and a choice for our amusement of all its vegetable and animal denizens. Yet, strange to say, all the early experiments proceeded on the assumption that a tank is a miniature ocean. Now the ocean somewhere is deep, and so, accordingly, the tanks were at first made deep, and that was the greatest of all the blunders that then abounded in the incipient realm of aquarian practice. After hecatombs of victims had been offered up, it was found that shallow tanks answered better than deep ones. I had the good fortune to call attention to the importance of shallow tanks and subdued daylight in the *Book of the Aquarium*, in time to contribute to that consolidation of aquarian principles which has resulted in the establishment of extensive tidal aquaria at the gardens of the Zoological Society of London, the Société d'Acclimatization at Paris, and the still more important and successful Aquaria at Berlin. It cannot be profitless to note the several points that have been successively demonstrated and established, because many persons are commencing the study of marine zoology, and need a little help from those who have had experience, and because, also, many who have had aquaria in their keeping for a series of years have not yet fully availed themselves of all the knowledge that has been accumulated on the subject.

Deep tanks are deep delusions. If it were possible to be content with a mere film of water over the animals they would, as a rule, prosper better than in depth enough to be completely submerged. The grand object is to present to the influence of the atmosphere the greatest possible extent of surface, and in shallow tanks this is of course accomplished. The slope-back tank is a heavy and rather cumbrous vehicle, and FOR THAT REASON it surpasses every other form where it is not possible to establish a tidal arrangement. The great mass of slate is not quickly influenced by changes of temperature, and the slope affords a great extent of rocky bottom for a picturesque disposition of the interior, and for the full growth of oxygen-making vegetation. This form also allows of the transmission of light in a subdued form, and an excess of light is impossible. Lastly, if the creatures confined in the vessel are of a roving habit, this propensity is encouraged, and wherever they roam they still remain visible.

Setting aside the notion of forming a complete submarine garden and zoological collection, let us consider the case somewhat in detail. The tank contains but a small bulk of water,

and this cannot easily be renewed in the event of its becoming foul. The largest tank ever made, and the largest series of tanks ever made, are but as drops as compared with the ocean, and the physiological and chemical phenomena taking place within them are on the same small scale as the tanks themselves. For instance, in place of the rush of the tide with its crest of foam and grinding of pebbles in a rock-pool, giving life and energy and abundance of food to the creatures that the pool shelters, in the tank there is of necessity a death-like stillness. This stillness reduces the capacity of the water for sustaining animal life, it is antagonistic to the generation of oxygen within or its absorption from the atmosphere. The algæ that grow in rock-clefts and among littoral deposits are fully exposed to solar light, and are sometimes laid bare for hours to a burning sun. I know of many lovely meadows of Ulva and Enteromorpha, but principally the former, which are daily almost as dry at low tide as the hot sands above the water-line. We dare not imitate this feature in tank management. Sunshine makes our small pools opaque and viscid with an extravagant growth of superfluous vegetation, and as to laying the shoal dry daily it is out of the question, except it may for some unhappy individual who has nothing else to do than to pump or dip, and sell himself soul and body to a boxful of worms and periwinkles. If we keep marine animals at all, it must be by simpler methods than these. Lastly, to avoid tediousness, the animals we imprison are imprisoned; in other words, they do not select the site for themselves as when free, and with the immeasurable floor of the ocean for their playground; nor once consigned to the slate prison can they shift their quarters, even if, as *may* be the case, those quarters are not exactly to their liking. Seeing that in this brief view of a few of the details of the case, there are many difficulties to be encountered, it is a matter for gratulation and perhaps for pride, that so much has been done to enlarge the boundaries of our knowledge of the life that abounds in the deep sea.

Having fitted up and tended tanks innumerable, I always found that the best "weeds" for ordinary purposes were *Ulva latissima* and *Enteromorpha compressa.* I have made some practical notes on other forms of algæ in the *Book of the Aquarium,* and have no intention now to repeat myself. I found, moreover, that the best of all materials for rockwork was mica-schist, because on this there soon occurred a spontaneous growth of microscopic algæ and confervæ, which is the best growth for a free generation of oxygen, and for keeping the tank in good condition. But with the best arrangements there was a certain amount of management wanted, and the object of fitting up the tank, of which a

description follows, was to endeavour to discover a way of making a marine tank take care of itself, and which must of course wholly depend upon the arrangements made in the first instance.

On the 24th of June, 1862, I fitted up a Warrington slope-back tank in my study. It was placed with its back to the window and at about fifteen inches from the glass, so as to receive but a moderate amount of daylight, and that wholly through the glass cover; light from the front being impossible. The tank is made wholly of slate, except the front, which is plate glass, and the back is placed at an angle of 40, which leaves a hollow cavity at the back; there is therefore no water chamber. The capacity of the tank is twenty gallons. Previous to fitting this tank I had by me a considerable quantity of *débris* from former experiments, and I set out in the full sun a large collection of old shells of oysters, whelks, serpulæ, and other odd gatherings that had lost their interest because their inmates had perished. Conspicuous amongst these were some pieces of tile and rock thickly coated with acorn barnacles. Fearing there might be some gelatinous matter, the result of deposition when the animals perished, I placed them in a vessel of water for a few days to dissolve out any organic detritus, and then placed them in the sun to be thoroughly sweetened. These several materials were used for covering the sloping slate back of the tank, and their adoption was a most decided gain; in fact, they soon told me that heavy blocks of mica-schist or *any other rock* were wholly unnecessary. These slate tanks are very heavy, and it is not desirable, unless a house is built expressly to receive them, to increase the weight by piling up rockwork inside them. In my case any serious addition to the combined weight of tank and water might cause the whole affair to subside from the study at the top of the house to the bed-room immediately below it, which would be an unpleasant circumstance, especially if it happened at night. But the bank of rocks at the back of the tank may be said to weigh nothing at all, consisting as it does wholly of old shells, and some of them very large, handsome, finely perforated and richly clothed shells of oysters from which the inmates departed many a year before. I found the shells weather-beaten on the beach. Please make a note of this therefore, and if you are fitting up an aquarium, secure for it a few hampers of sea-side findings of an ancient shelly kind, and let the chief bulk consist of the largest and most ancient of the beach-strewn oyster shells that can be obtained. They are worth all the cost of carriage and more to an enthusiast in those matters, as will be seen presently.

The tank was fitted with these substitutes for rock, and

filled with sea-water. I put in about half-a-dozen tufts of Ulva and Enteromorpha, and after four days had elapsed I stocked it with animal life as follows:—Six *Actinia mesembryanthemum,* two *Sagartia viduata* (anguicoma), four *Sagartia bellis,* four *Bunodes gemmacea,* two *Sagartia dianthus,* one fine block of *Corynactis viridis,* and twelve periwinkles. I left all alone for a week, and at the end of that period most of the zoophytes had shrunk up, refusing any longer to display their gorgeous rays of flowery tentacles, and a black spot in one corner told of a death that had occurred. I soon found that the defunct party was a periwinkle, and he was removed. Three or four days afterwards a slimy appearance and a slight cloud indicated another death, and this time it was one of the *Bunodes gemmacea.* The next day I lost a *mesembryanthemum.*

When the last corpse was removed, a cloud rose from the spot where it had lain—the thermometer in the room being then at 83°, and the water was in a bad state. I was compelled, therefore, to remove the animals to a shallow pan, and leave them uncovered for a time, while I filtered enough water through charcoal to enable me to cover them with a thin film. The remainder of the water was exposed in a vessel to the sunshine for three days, and the empty tank was well cleansed and dried, and the shells exposed to sunshine to effect a perfect purification. While in the shallow pan I lost my block of *Corynactis*—every one perished. The tank was refitted, but the water was by no means so bright as when it was dipped from the salt sea. I made good what had been lost by evaporation by adding fresh water till the specific gravity bulb showed an inclination to sink. The same day a fine *dianthus* floated about instead of adhering; all the rest adhered well, and there was a fine display of tentacles, as is commonly the case after the animals have been disturbed. I removed the *dianthus,* and gave him a vessel to himself; but he never took hold, and died without a murmur. In the course of the summer I lost two more periwinkles; but though they lay some time decomposing before I knew it, I did not disturb the water, being content to remove them quietly, and leave the water and its inmates to fight it out.

From the time of first fitting the tank to last Midsummer-day was a period of three years. On that day, considering the experiment satisfactory and sufficiently lengthened out, I distributed the little collection. At the time of distribution the stock consisted of five *A. mesembryanthemum,* two *S. viduata,* one *S. dianthus,* four *S. bellis,* four *B. gemmacea,* and eight periwinkles. The state of the tank was also very different to what it was for some months after the first furnishing.

During the first winter all the tufts of Ulva and Enteromorpha perished. I thought then, and I still think, that in winter such a tank ought to be turned round to face the light, and be turned back to its former position some time at the end of February or the beginning of March. I wish I had done so, it would have made the experiment more complete probably. However, I did not; the fact is, such things are not easily moved, and so, if it occurs to one's mind to move them, the intention is scarcely likely to be carried into effect. Before the first winter set in, there was a perceptible green growth on some of the shells and stones, but not till the summer of 1863 was the growth of vegetation at all general. Then I became aware of the immense value of the old shells; for the old, rough, much pierced, and sponge-covered oyster shells acquired a rich deep green hue, and equally well clothed were the shells of the barnacles. On these latter, indeed, vegetation *first appeared,* and they are, no doubt, invaluable if well cleansed of animal matter before being inserted. But from first to last there has never occurred a single instance of "pea-soupiness," no ropy confervæ have been produced. The vegetation amounts to no more than a velvet-like, deep green coating on shells and stones, and this is richest on barnacles and oyster shells.

In every case of death subsequent to those particularized above, I have allowed the water to right itself, which it does in the course of a few days, or a week, the cloud spreading at first all over the tank, and then contracting to a black spot, which marks where the animal perished, and in the course of a fortnight (or less) this entirely disappears. It is an important fact that when the animals become seasoned, and the whole affair is left alone, one death does not necessarily lead to another, as in a tank heavily stocked, and exposed to a strong light; but as soon as the cloud caused by decomposition begins to spread, all the creatures close their disks, the mollusks contract and draw down their operculi, and in this state of torpor they all remain till things improve, when they again resume their activities. The most frequent cause of impurity is the result of feeding; for scraps of oyster or mussel given them are sometimes immediately ejected, and fall among the shells, and remain hidden, to cause putrefaction. The only means of preventing this is to remove every particle of food not received by the animals; to feed seldom, so as to increase the probability that food will be welcome; and, lastly, to feed only on bright mornings, when the water is nearly transparent. Once a fortnight is often enough to feed all the summer, and once in five or six weeks during winter.

During the first few months after the tank was fitted, it

had much attention, and was kept to a regular standard of density. By degrees I slackened in my attentions, and this did not result in disaster. Once, during the summer of 1863, after long absence from home, and much absolute neglect of the tank, I observed that the water had sunk to a low level, and I inserted a hydrometer. What was my horror to find it register a specific gravity of 1,416! Yet even then the *mesembryanthemums* appeared as lively as usual, and *dianthus* was slowly imbibing and contracting, puffing itself out to enormous dimensions, and then becoming constricted, as if tied with a cord, as is the wont of this lovely conjuror of the deep. I found after a time that instead of adding fresh water by slow degrees, as I did at first, I might add sufficient at once to reduce the specific gravity to 1,028 without any harm to the inmates. They would, perhaps, close for a few minutes, and then shine out with greater splendour than before. In every case when the water acquired an unnatural degree of density, the periwinkles attached themselves firmly, shrunk down deep into their shells, and drew their shutters down as tight as possible, and so remained till things came right again, when they would make up for lost time by increased activity and voracity. Since then the tank has frequently lost as much as two inches depth of water by evaporation, and I once found the specific gravity to be 1,529! Yet nothing worse happened than a general torpor and constriction, and a few hours after the reduction of the density to a proper standard, the creatures were all as lively as ever.

I have referred to cloudiness caused by deaths, but it is right I should say, that with the exception of those few occurrences, the tank has always been delightfully bright, and there never occurred any growth on the front glass. When unstocked on the 24th of June last, the water had the same bright appearance as when it was first dipped in the English Channel; but there were floating on the surface some small patches of brown flocculent matter, a sort of scum which I thought resulted from a gradual accumulation of a linty sort of dust, the result of the tank being amongst books, and which had crept in by the small slit of the sixteenth of an inch which intervenes between the edge of the glass cover and the side of the tank at each end. The water was always rich in microscopic life, and its capacity for sustaining a mixed collection of marine animals appears to be in the proportion of not more than one to a gallon. For so large a creature as a *dianthus* I should think two gallons none too much, with a shallow vessel, and vegetation produced *in situ* as essential elements of success; whereas with similar advantages two *mesembryanthemums* or daisies might be kept in a gallon of water. Even a periwinkle needs nearly a gallon

of water, spread out over a considerable surface, to keep it alive two or three years. But by adopting this liberal rule, we make an end of the necessity for ærating, and for frequently renewing the stock of plants and animals.

PLEASANT WAYS IN SCIENCE.

No. I.—Curiosities of Motion.

Under this title we propose from time to time to consider divers scientific questions in an informal manner, seizing rather upon their amusing, pictorial, or ideal aspects than attempting to build them up into the technical form of a methodical treatise. Our object is to bring interesting results within the reach of those who may not have time or opportunity for arriving at them through a regular course of study, and to render assistance to those who diligently collect facts, but require help in the art of associating them together, so as to form a philosophy. We shall begin with some entertaining facts concerning Motion.

Of all earth's millions of human inhabitants how few know when they awake in the morning what enormous journeys they must take before the day will be over, and the dawn of the morrow will greet their eyes. It would alarm a Londoner to tell him at daybreak that he should be shot off to Persia with the speed of a rifle bullet; and indeed we know no artificial mode of spinning him onward at anything like such a rate, even for short distances, with due regard to the continuance of his life. Nature, however, rolls him along with tremendous speed as the earth careers from west to east. In the course of twenty-three hours fifty-six minutes, four seconds, and nine hundredths of a second, the earth turns round on its imaginary axis. If at any moment we thought ourselves upright, we must remember that since that moment flitted away, we have been turned topsy-turvy, and brought right again exactly in that space of time. How do we know this? It is one of the many things which the stars tell those who worship them with the homage which science pays to their brilliant and yet *unseen* orbs.* If we set up a tall convenient mark, or take a distant church spire, a lightning rod or a flag-staff, and note when any particular star is exactly over it, in precisely the time we have given, that star will be again in its place; and as

* The reader may consider as part of this series the paper, "We never See the Stars," which see to explain the paradox in the text. (See Vol. v., p. 47.)

all stars tell us the same tale, we accept their evidence that our big earth-ball, which at the equator is nearly twenty-five* thousand miles in circumference, turns round its own axis in a little less than twice twelve hours.† Now if we could get a fairy stool to stand upon nothing, above the earth's surface at the equator, and we could sit upon it, and watch the globe spin round, it would in the course of a day and night spread before us its five-and-twenty thousand miles of successive scenery. Great cities with their "cloud capped towers" and "gorgeous palaces," cultivated fields, primeval forests, desert lands, and ocean with its varied shores, would come and vanish like the thoughts and pictures of a wondrous dream. According to this supposition we should be quite *still*, while every point on the equatorial circle would travel through a space equal to the globe's circumference in its daily journey. As facts go, we are practically still, or move so little in the course of the day that we may be considered so, and the globe takes us round with it in the prodigious tour we have described, not bringing before our eyes a succession of terrestrial scenes, but unfolding the heavens as a scroll, and enabling us to read their glorious characters as successive portions rise to our view in the east and vanish in the west. The earth's velocity of rotation at the equator is 1520 feet in a second—rather less than the initial velocity of a rifle-ball. In our latitude it is about 820 feet per second.

In addition to this journey of rotation, we have another one to take, namely, that of revolution round the sun, and this we accomplish at an average rate of sixty-eight thousand and forty miles an hour.

Thus, two swift motions operate upon us, and we feel them not—only know them by reasoning from facts that afford no evidence of them to an uneducated mind. The common eye cannot fail to see the sun, and moon, and stars rise and set. A more watchful eye notices that at different seasons our skies exhibit different groups of stars, in regular and recurring succession.

* The diameter of the earth is 7925·604 miles, and its circumference 24,809 miles. The circumference of a circle is rather more than three times its diameter, say 3·14159 times.

† It is not necessary for our present purpose to take into account the effect produced upon the period between two successive advents of any star on the meridian, by the motion of the poles of the earth, which do not constantly point to the same place in the heavens. For explanation of this, the reader can see Sir J. Herschel's *Outlines of Astronomy*. The difference between a solar day, averaging twenty-four hours, and a sidereal day, must be borne in mind. As the change in the position of the earth's poles is small and slow, and as the stars are too remote for their proper motions to affect the question, we may consider them as fixed points, to which the same meridian returns in equal times. The sun does not appear fixed. It seems to traverse the heavens in its annual motion in a direction opposite to its diurnal motion, so that the latter motion appears slower than the diurnal motion of the stars, and the solar day is so much longer.

Thus, something must move—but what, and how? The pole star moves so little, or in so small a circle, as to seem the pivot about which the heavens turn, and if all the stars were supposed fixed in crystal spheres, the motions of such spheres would account for very much that is observed. Thus, the ancients for a long time had no notion of the true system. They took the earth for a thing firmly fixed, or rooted, and ascribed all celestial movements to other bodies more or less distant from it. A greater precision of observing power, and a larger store of facts, gradually revealed the real state of the case.

How do we ever know that we move or are moved, or that anything moves? In the earth journeys we unconsciously accomplish we have illustrations of motions that carry us along and which we cannot feel. On a dark night, or with eyes shut, in a railway train, a rumbling and shaking informs us that we are not still; but we easily get confused as to which way we are going, if the motion is smooth enough not to force the fact upon our attention. Our chief evidence that motion has taken place is derived from the information afforded by our eyes that certain things have changed their relative positions. If an object seen one minute on our right, is seen the next minute on our left, either the object has gone half round us, or we have gone half round ourselves. If two objects are situated in front of us, so that when we look straight a-head we can just see both together at the same time, and if a few minutes later we can only see one at a time, either they must have receded from each other, or we must have approached them, so that their actual distance occupies a greater apparent space than it did before. At a distance, the view of a whole town is compressed into the size of a sixpence a foot off of our eyes; nearer, a single brick is more than we can see at once. Let us suppose that we see the town in its sixpenny dimensions, and that presently its apparent magnitude far exceeds the capabilities of a single glance. How can we tell whether we have walked to the town, or the town has walked to us? "What a ridiculous question," would be a general exclamation, and yet how many supposed well educated people could give an intelligible proof of what really occurred? It would not do for them merely to say that they knew they moved on, because they passed things on the road. We should ask how they knew the things did not pass them. If two bodies are moving in opposite direction, with equal or different velocities, their positions with reference to each other at any given moment will be the same, as if one kept quite still and its motion were added to that of the other, and in order to prove whether one or both had moved, reference must be made to some fixed and ascertainable point.

Being parodoxically inclined, we will add that such a *fixed* point may be a rapidly moving one, and will do just as well, nay, in most cases, it would not enjoy the merit of what we call "fixity" if it did not travel at a great rate. Suppose Westminster Abbey were miraculously impressed with, and enabled to perform, the duty of standing still, while Charing Cross and the Houses of Parliament went with the earth's surface on its diurnal tour; the angle made by lines connecting these buildings, as seen from Charing Cross, would rapidly change, and the inhabitants of London, not let into the secret, might think the old abbey was running away. As the earth moves, carrying along with it its burden of hills, buildings, and trees, the "fixity" of any one of these objects depends upon its partaking of exactly its own share of the motion common to all. The motion of the earth, from west to east, does not hinder the railway from carrying us from east to west. It is as easy to walk from St. Paul's to Charing Cross, as from Charing Cross to St. Paul's, and no passenger feels whether he is going as the earth goes, or in opposition to her diurnal course.

In order to become aware of motion we want comparison. An object moving on the earth's surface in a direction or with a velocity different from the direction and velocity common to all territorial objects, manifests its special motion by taking up a new place in reference to other objects, and we assume that the other objects have not moved because their position is unchanged with reference to each other.

In the smoothest form of travelling, if we do not look at objects for comparison, we scarcely know that we are moved. If a jerk occurs, one part of our body immediately complains that its position, with reference to other parts, is violently changed. An extreme instance of this sort of action is when a cannon ball takes off a leg by communicating to it a velocity with which the rest of the unfortunate individual cannot possibly keep pace.

The velocity with which certain motions take place is far beyond our possibility of conception. We see them expressed in lines of figures that soon cease to have any meaning which understandings can grasp. An uneducated man has no conception of a few thousands. To a savage, all beyond twenty or a hundred is vaguely presented as a great many. An ordinary man of business grasps the notion of a million, though only to some extent. Billions, trillions, and their connexions, seem all alike—vast, vague, and not to be comprehended. An astronomer or mathematician penetrates their mysteries up to a certain point; but he is soon brought to a condition of non-apprehension, and gigantic numbers come at last to mean to

him just what smaller numbers do to the savage—a quantity greater than he can adequately comprehend.

Astronomy brings us into acquaintance with motions of enormous velocity traversing prodigious spaces, chemistry and physics exhibit motions equally wonderful for their incalculable speed, and yet performed in spaces too minute for us to conceive. A swallow in its swiftest flight is said to move at the rate of ninety miles an hour; Mercury, in its journey round the sun, performs about 109,360 miles in an hour;* Venus, being less near the centre of our system, is contented with a march of 80,000 miles an hour; while our earth, in the same time, traverses 68,040 miles. These are wonderfully quick motions, but they are nothing to the velocity of light, which travels, according to recent experiments, at the rate of about 185,000 miles in a second.†

A great quantity of evidence leads to the conclusion that light is a motion of an extremely subtle fluid, as sound is the motion of air.‡ Now, wave motion is somewhat complicated. If two persons hold a long rope, and one lifts his end rapidly up and down, a wave motion visibly passes from one end to the other. A portion of the rope rises and falls, passing its motion on to the next portion, until the whole rope is affected by a beautiful series of wave lines. Now the velocity with which each portion rises and falls is one thing, and the velocity with which the wave form is transmitted from one part to another is another thing; and when wave actions take place, there may be an enormous difference between these two velocities. When we speak of light coming to us from sun or star with a rapidity of 185,000 miles a second, we mean that the *wave form* reaches us with that degree of speed; but the velocity with which the ether particles rise and fall in their vibrations is infinitely more swift. When we investigate sounds, we find their pitch depends upon the slowness or rapidity of their motions—a metallic strip that vibrates with great rapidity giving an acute sound, which becomes graver as the velocity of vibration is diminished. A complete vibration is the oscillation of a particle once forwards and once backwards through a greater or smaller arc. The intensity of a sound depends on the size or amplitude of the vibration, and its pitch upon their velocity.

* These figures are taken from Sir J. Herschel's *Outlines of Astronomy*.

† This velocity of light corresponds with the distance now assigned to the sun upon astronomical grounds—namely, 91,600,000 miles.

‡ It must not be understood that sound is exclusively produced by vibrations of common air. In *Ganot's Physics*, translated by Atkinson, we find it well stated that "sound is a peculiar sensation excited in the organ of hearing by the vibratory motion of bodies, when this motion is transmitted to the ear through an elastic medium." Solids and fluids will conduct sounds, and so will all gases. The sounds we commonly hear and make use of are vibrations of atmospheric air.

By comparing the note yielded by vibrations whose velocity was known with that of the buzzing of a gnat, it has been estimated that this little creature vibrates its wings fifteen thousand times in a second.*

We have spoken of the velocity with which the forms of light waves travel, so that they reach us from the sun in eight minutes, thirteen seconds, and three-tenths of a second. Tremendous as is this speed, it looks small when compared with that of the vibrations which the ether particles experience. Thus, "when the ether makes 450 billions of oscillations in a second, the sensation of red light is produced, while 780 billions of oscillations in a second produce violet light."†

If light only takes a trifle more than eight minutes to come nearly ninety-two millions of miles from the sun, the time occupied by its passage across an ordinary room would seem too small for possible appreciation, and yet M. Foucault experimentally determined its velocity by operating in such a limited space. His proceedings illustrate the important results that may flow from the employment of accurate means of measuring very small quantities of motion. Before attempting to explain the use made by M. Foucault of Mr. Wheatstone's revolving mirror, let us call attention to a well-known electrical experiment, in which a number of spokes set in a circle are made to revolve rapidly in a dark room. They are then illuminated by an electric spark, and found to *appear* at rest. The light has come and gone so fast that the spokes have not had time to make any appreciable change of position. We need not be surprised at this when Wheatstone found that the spark light‡ "does not last the millionth part of a second of time," yet this minute time sufficed to make the light vibrations to excite the optical apparatus of the human eye, by communicating to it a quantity of motion sufficient to cause the sensation of light.

As a step towards understanding Mr. Wheatstone's measuring apparatus, let the reader take a small looking-glass in both hands, holding it up by the middle of the frame, and gently spin it round so that the bottom shall be where the top was, and *vice versâ*. Let a candle be placed in front of this mirror, so that at the moment it stands upright it shall throw a reflection of it upon the wall. The reflected image will then occupy a certain spot on the wall, and as often as the mirror comes round to the same place, it will throw the reflection on the same spot. If, however, immediately after one reflection has been thrown on the wall, the candle is moved before the

* *Ganot's Physics*, by Atkinson, p. 164.

† *Ganot's Physics*, by Atkinson, p. 404. ‡ *Noad's Electricity*, p. 116.

mirror comes back to its place, the second reflection will be on a different spot to the first, and the distance between the two reflections will enable an experimenter to tell how much the candle has been moved. If, moreover, the time occupied by the mirror in rotating is known, it will become evident that in that time the candle's motion was effected.

Let us now suppose a mirror rotating with great velocity, that a ray of light falls upon it, and is reflected by it on a given spot. Let this same ray of light, after traversing a certain number of feet, be a second time thrown upon the mirror, and a second time reflected by it. If during the time occupied by the ray of light in the journey it made between the first reflection and the second was sufficient to allow the mirror to perform any appreciable part of its rotation, the light ray must, on its second arrival at the mirror's surface, have struck that surface at an angle differing from the first. It is evident that as light moves so quickly, the mirror must be very quick for the faintest difference of position to have occurred; but by making a rotation of 600 to 800 turns in a second, and by viewing the image through a magnifying eye-piece, M. Foucault obtained a sensible distance between the first and second reflections, although the light only passed through a space of twenty-seven feet.*

In the present state of science, we seem justified in regarding light, heat, and elasticity as modes of motion, and we may suppose that they all exhibit the two kinds of motion we have described—the oscillations of particles in a limited space, and the indefinite propagation of the wave form. Heat is also a mode of motion, and a continual cause of motion in every substance and particle that it acts upon. Heat performs two functions, which are evidenced in a different manner to our senses; it expands bodies by forcing their particles further apart, and it makes bodies hot by communicating to their particles a particular kind of motion. If a certain quantity of heat is added to various substances, it will not make them all equally hot; but the heat which does not make itself cognizant to our senses in the form of augmented warmth is occupied in internal work, and produces a movement of particles that may become known to us in some other way. "To raise a pound of water one degree would require thirty times the amount of heat necessary to raise a pound of mercury one degree."†

When chemical attractions operate powerfully, as when a mixture of oxygen and hydrogen is ignited by an electric spark, the atoms of the gases rush together with inconceivable

* *Ganot's Physics*, already referred to, contains a description, with diagrams, of this experiment.

† *Tyndall's Heat as a Mode of Motion.* Second Edition, p. 146.

velocity, and out of this intense development of motion a sudden heat ensues.

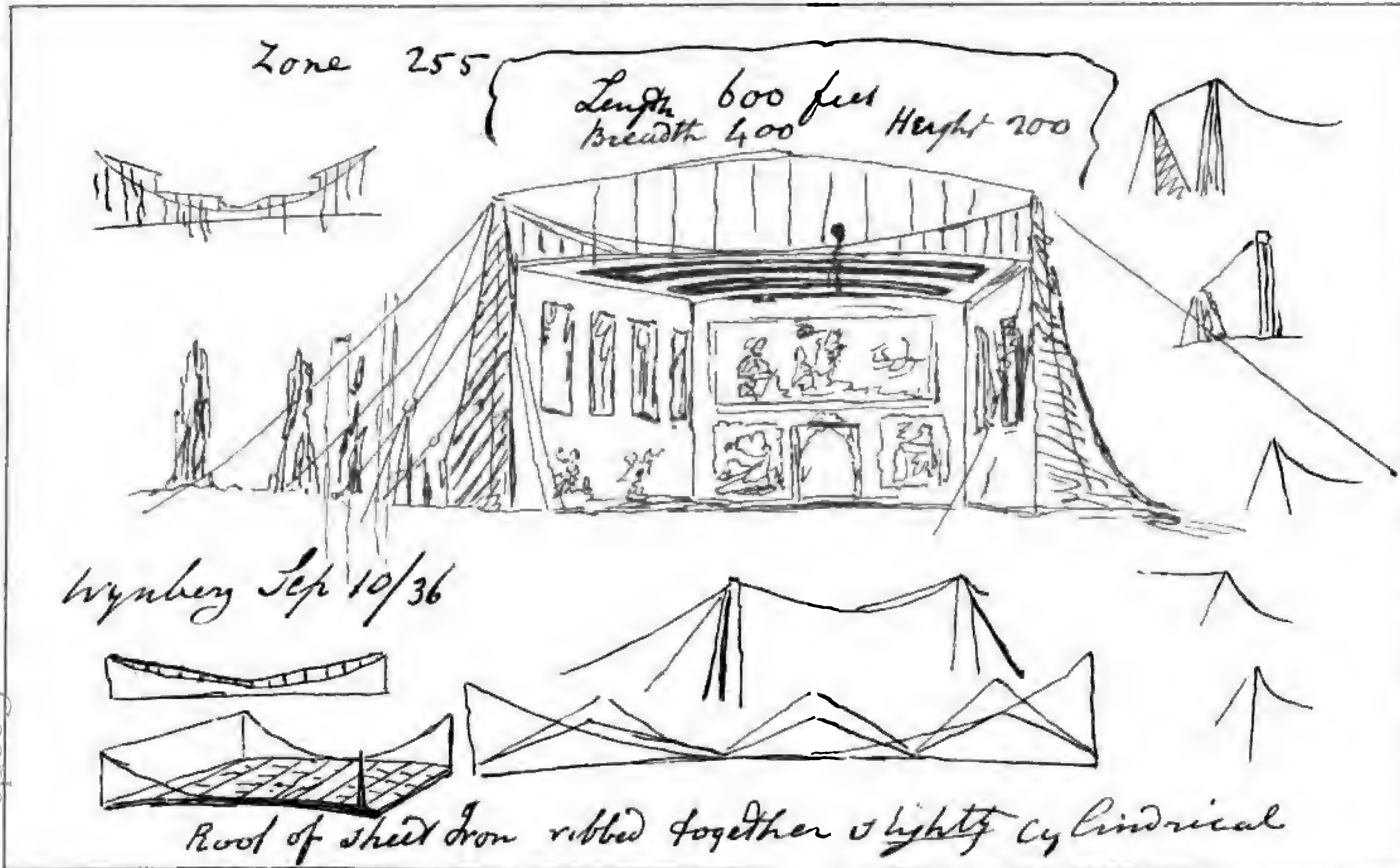
Heat, magnetism, and electricity are ceaselessly occupied in generating motion, so that no substance we are acquainted with is absolutely still. As a mass it may be at rest; that is, it may only partake of its necessary share of the common motion of the globe and the system to which it belongs; but its molecules are never quiet. The least change of temperature moves them more or less, the least change of position places them in a different relation to the magnetic axes of the earth, and then again a change is produced, at any rate, in most bodies. Every house affords an illustration of the way in which internal motions occur in substances that might be thought free from detrimental disturbance. Bell-wires become rotten because the particles of the copper have rearranged themselves in a new form, by which cohesion is lessened; and iron has a tendency to grow brittle, apparently under the influence of continued concussions, though this is not perfectly clear. A piece of glass tube might be thought a settled thing, so far as its internal structure is concerned, but thermometer makers tell us that if newly-made tubes are exactly graduated, sufficient changes are likely to occur in the course of a few months to affect the accuracy of the instrument. Metallic substances, such as gold and German silver, are employed to make the vacuum chambers used in the construction of aneroid barometers, and these, too, are subject to molecular motions, which change the elastic power of their delicate walls, and no one has yet arrived at the art of making these vacuum chambers so as to insure this action being so small as to have no practical effect in lessening their accuracy. Those which stand tests for six or more months are likely to remain good; but a new instrument, good to-day, may be worth little next year.

From the internal motions to which all bodies are subject, it is very difficult to make a good standard measure of length, and such a standard can only be perfectly right at the exact temperature to which it was adjusted. Instruments have been contrived by which motions of expansion and contraction can be measured to infinitesimal portions of an inch, and by which the exact length of any object can be taken, or the minutest deviations from a true plane surface detected. As a specimen of this class of instrument we may mention a *planometer*, and our description is taken from one constructed by Mr. Browning. An aluminium circle stands upon three legs, arranged at equidistant points of its circumference, and of precisely the same length. In the centre of the circle is another leg, which can be elevated or depressed by a delicate screw, and the extent

of this movement read off on the edge of the circle by a vernier. If all four legs are exactly of the same length, and the instrument is placed on a plate of glass, or any other substance which is not a true plane, one or more of the legs will not touch the surface when the others do, and if a slight angular shove is then given to the instrument it will revolve about the central leg if that leg touches any point, which it can easily be made to do. We took a plate of glass which all four legs touched, and then we expanded a portion of the glass by the heat of one or two fingers imposed upon it for a minute. The particles of the glass experienced sufficient motion to lift some legs of the instrument higher than the others, and this extremely slight movement allowed us to rotate the instrument about its central leg. This particular instrument will measure inequalities not exceeding a fifty-thousandth of an inch.

Another kind of instrument, by which the amount of motion performed in infinitesimal quantities of time can be estimated, is called a chronograph. In this sort of apparatus there must be a uniform rate of motion impressed upon one part, say a wheel, and this part must transmit its motion through long levers and through larger wheels, so that a very small motion of the first part leads to a very much greater motion of some other part. If one part moves through an infinitesimal space for a hundredth, a thousandth, or a hundred thousandth of a second, it must cause another part to move enough for the eye, with or without optical aid, to be able to see and measure the space that has been traversed. As an illustration of one way of using such a machine, let us suppose that an electric current suddenly sent through it sets it going, and at the same moment fires off a gun. Let the ball strike and cut through the wire conveying the current, and instantaneously stop the machine. An observer can then see that the index hand of the apparatus has moved through a space corresponding with a given portion of time, say a thousandth of a second, and thus he knows that from the firing of the gun to the ball's striking the wire a thousandth of a second elapsed.

Motion is a necessary condition of life. In a living organism everything moves. If new matter is taken in and digested we have nothing more than a regulated series of motions, by means of which food substances are taken to pieces in a methodical manner, and their atoms built up in fresh forms. If old matter is eliminated from the system, here again are motions regulated as to their character, their quantity, and their velocity. If we see, motion is communicated to the eye; if we hear, motion is communicated to the ear; if we think or feel, motion affects the brain. Countless myriads of regulated and co-ordinated motions occur every instant that an animal lives. Change their order,



Facsimile of a Sketch by Sir J. F. W. Herschel Bt. in 1836, in illustration of the possible construction of a Suspension Roof for a Hall of large dimensions.

[illegible] their dir[illegible] force, their co[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] possible for [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] again. [illegible] for [illegible]

CHAIN SUSPENSION BRIDGES.

BY SIR [illegible], BART., [illegible]

with [illegible] the Original [illegible]

[illegible] interesting [illegible] Sir John [illegible] [illegible] [illegible] living [illegible]

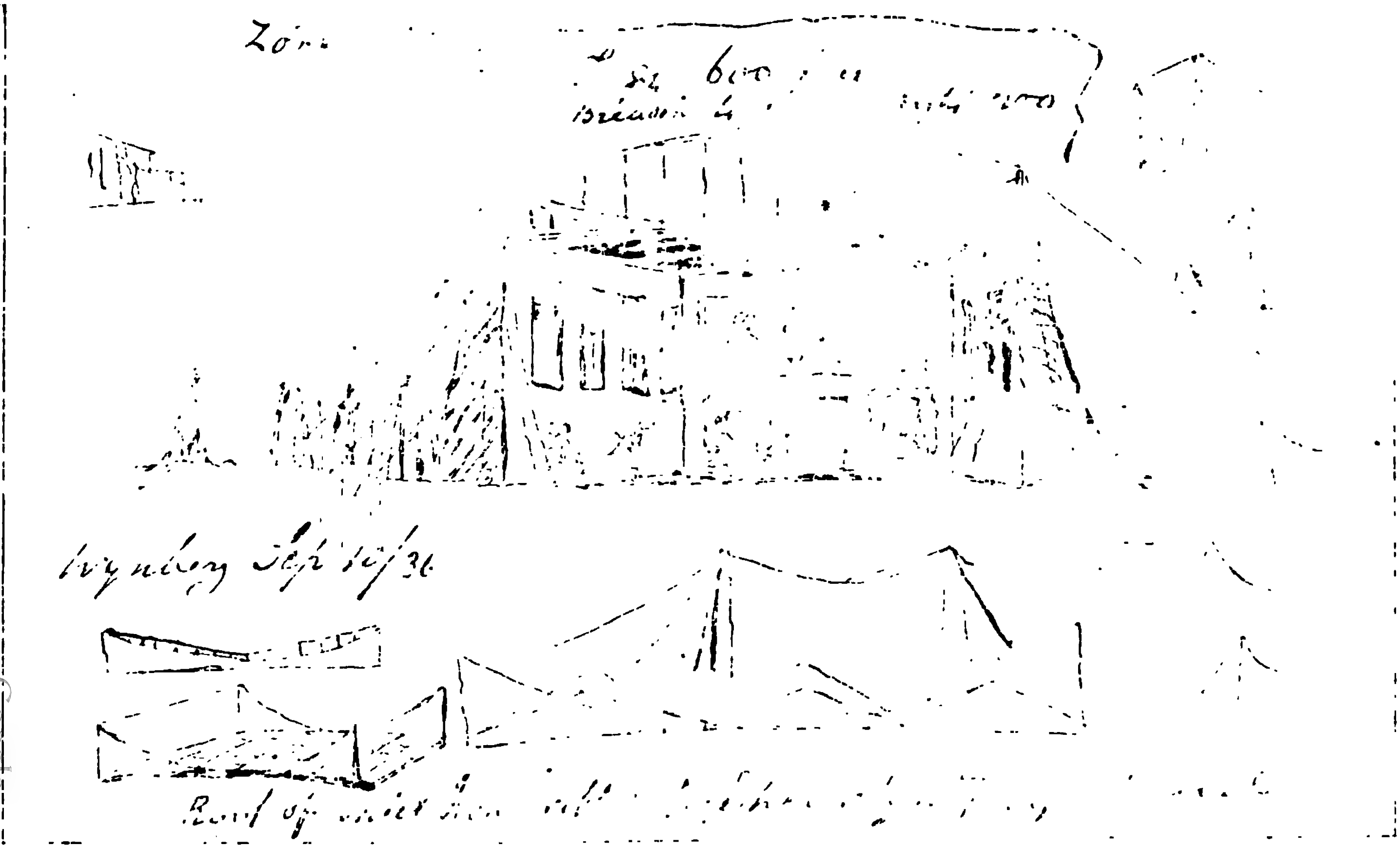
The principle of [illegible] will [illegible] [illegible] [illegible] accustomed to [illegible] (the front [illegible] [illegible] of [illegible] over the [illegible] persons [illegible] and if so, it [illegible] person I had anticipated him by [illegible]

To the Editor of the INSTITUTION [illegible]

Cold[illegible], [illegible]

SIR,—In your number for September I [illegible] the following [illegible] under your miscellaneous head [illegible], "[illegible] of Suspension Bridges." "M. [illegible], a French civil engineer, [illegible] [illegible] very far greater [illegible] attempted by [illegible] a suspension [illegible] [illegible] over suspension bridges [illegible] injurious effect produced by varying loads."

Allow me, [illegible] the absence of any further [illegible] [illegible]laire's [illegible], to submit for your inspection [illegible] [illegible], for [illegible] of your readers, through the [illegible] [illegible] *fac-simile* of a rude sketch of a [illegible] [illegible] feet in length, 400 [illegible] breadth, and 200 [illegible] find preserved among my papers, and [illegible] (as I have no doubt it is) that of [illegible] thirty years for the lapse of time. [illegible] with that of the other memo[illegible] the [illegible]



their character, their direction, their force, their co-ordination, and it dies, and then physical and chemical actions, with the co-operation of the minute organisms which the microscope reveals, pull the fabric to pieces, imparting new motions to its molecules, and as soon as they are dispersed, other forces imparting motion take them in their grasp, arranging them in fresh patterns, causing them to enter in new combinations, again to be destroyed by other motions, reconstructed again, and thus "On, on, for ever."

CHAIN SUSPENSION ROOFS.

BY SIR JOHN HERSCHEL, BART., K.H., ETC., ETC.

(*With facsimile of the Original Sketch.*)

We have much pleasure in publishing the following interesting letter from Sir John Herschel, and in presenting to our readers a lithographed *facsimile* of the original rough sketch embodying his design.

The principle of this mode of construction will be readily intelligible to engineers; but for the benefit of those who are not accustomed to rough diagrams, we may state that the sketch represents (the front wall being removed) a perspective view of the interior of a great hall. A light iron roof, of double convex form, and internally strengthened by angular supports, is kept in its place by chains, attached to it, and passing over the side walls of the apartment, which act like the piers of a suspension bridge. This we take to be the plan of M. Lehaire, and if so, it will be seen that Sir John Herschel had anticipated him by thirty years.

To the Editor of the Intellectual Observer.

Collingwood, *October* 3, 1865.

Sir,—In your number for September I observe the following notice under your miscellaneous heading, "Roofs on the Principle of Suspension Bridges." "M. Lehaire, a French civil engineer, proposes to construct roofs having a span very far greater than hitherto attempted by supporting them with suspension cables. They will have an advantage over suspension bridges in being free from the injurious effect produced by varying loads."

Allow me, in the absence of any further knowledge of M. Lehaire's suggestion, to submit for your inspection (and if you think proper, for that of your readers, through the medium of a woodcut) the exact *facsimile* of a rude sketch of a plan for constructing a hall 600 feet in length, 400 in breadth, and 200 in height, which I find preserved among my papers, and which, if the date it bears be (as I have no doubt it is) that of its execution, assigns nearly thirty years for the lapse of time. The handwriting is the same with that of the other memoranda on the paper, and the discolora-

tion of the ink, which is pretty considerable, also exactly similar. On first turning up the sketch, I had some doubt on this point, my habit of dating during the latter part of my residence at the Cape being "Feldhausen," the name of my residence, an insulated house near Wynberg; but from the subjoined extract of a letter from Captain Horsburgh,* I find that I was occasionally also in the habit of dating from Wynberg.

I have the honour, etc., etc., sir, your obedient servant,

J. F. W. HERSCHEL.

P.S.—The roof proposed being light, no great strength of cable would be necessary. A series of wire ropes, like those which supported the old suspension bridge over the Rhone at Valence, would answer every purpose, and be very cheap.

ON THE SIZE OF TELESCOPIC STAR-DISKS.

BY THE REV. W. R. DAWES.

WE have much pleasure in laying before our readers the following important letter from Mr. Dawes, on a subject now exciting very general attention:—

"The remarks in the INTELLECTUAL OBSERVER of July and October, on the little discussion which has arisen respecting the size of telescopic star-disks, seemed to show that the object of my statements on the subject was in some respects misapprehended.

"My remarks at the June meeting of the Royal Astronomical Society had specific reference to two points on which it was desired to ascertain the results of careful experiments—namely:—

"'1. Is the size of telescopic disks influenced by the *different curves* used by opticians for the correction of the spherical aberration of an object-glass?

"'2. Is it affected by the ratio of the focal length to the aperture?'

"It was distinctly understood that *the spherical aberration was well corrected*, though by different curves, in all the object-glasses compared; and that the observations were made on the *same star*. My reply to the questions expressed simply, that the results of numerous comparisons which I had made with telescopes by the eight different opticians named, had proved that the variety of the curves employed by them produced no perceptible difference in the size of the disk, and

* (EXTRACT.)

"MY DEAR SIR,—Your valuable and esteemed letter, dated Wynberg, July 7, 1834, etc., etc.

(Signed) "JAS. HORSBURGH.

"Sir J. F. W. Herschel, Wynberg,
"Cape Town, Cape of Good Hope."

also that I had come to the same conclusion with reference to the ratio of the focal length to the aperture. Except the difference of the curves, and of the ratio of the focal length to the aperture, all other things were supposed to be alike. The magnifying power, for instance, being as nearly as possible the same. The outstanding chromatic dispersion produces no effect on the *size* of the disk, but only on its *colour*, which is of course very perceptible under high magnifiers.

"The application of a circular patch to the centre of an object-glass has been frequently employed in my double-star observations since the year 1831; having been suggested to me by Sir John Herschel, in a letter dated in that year. It is also mentioned in the introduction to his *Measurements of 364 Double Stars*, published in 1832, where he says, 'The action of a telescope is often surprisingly improved by stopping out the central rays by a round disk from a fifth to a sixth of the diameter of the object-glass, which should be well centred.' See *Memoirs of Royal Astronomical Society*, Vol. v., Part i., p. 48. And in the introduction to my first series of double star measures, I have recorded my use of it, and have remarked, 'The effect is decidedly good on the stars themselves, if not too faint to bear the loss of light. The *separating* power of the telescope is increased, but the concentric rings accompanying bright stars are multiplied, and rendered more luminous, and are also thrown further from the disk. Hence small stars may often be obscured or distorted by the ring passing through them.' (*Memoirs of Royal Astronomical Society*, Vol. viii. p. 63.)

"The effect of the different degrees of transparency in object-glasses, arising from the different colour of the glass, is very small comparatively, as may easily be proved by comparing together the separating power of a refractor with that of a good Newtonian (metal) reflector of the *same aperture*; the refractor having a central disk on the object-glass of the same size as the plane mirror of the Newtonian. The reflector will not have more than half the *illuminating* power of the refractor, yet the difference in its *separating* power, arising from the smaller size of the disks, will be but trifling, much the same in fact as if the close stars of ζ *Cancri* were both of the size of the smaller of the two.

"To assert, as Dr. Steinheil supposed I did, that with a given aperture, the disks of *all* stars, whether of the 1st or the 9th magnitude, would appear of the same size, would be simply absurd. It appears that he overlooked the limitation distinctly expressed by the President in the words, 'With regard to the size of the spurious disk of the *same star*,' etc., and it was to this that my reply referred.—I am, sir, your obedient servant, "W. R. DAWES."

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1885.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Tension of Vapour.	Relative Humidity.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°	inch.		°	°	°	0—10		inches.
July 1	29·750	55·8	46·5	·454	·72	68·3	52·5	15·8	10, 8, 3	NW by N, N by E, NW by N.	0·350
„ 2	...	...	...	...	...	73·9	48·1	25·8	...	... ...	·004
„ 3	30·060	67·9	53·7	·678	·62	76·7	49·6	27·1	4, 6, 1	WSW, SW by S, —	·000
„ 4	29·959	71·7	54·9	·768	·57	80·0	50·7	29·3	1, 2, 3	S by W, S by W, SW.	·000
„ 5	30·052	67·7	60·2	·674	·78	76·8	61·0	15·8	6, 6, 3	W by S, SW, SSW.	·000
„ 6	29·835	70·3	66·5	·734	·88	80·3	61·1	19·2	7, 9, 3	E, W by S, E by N.	·123
„ 7	29·754	63·4	54·3	·585	·74	70·6	60·6	10·0	8, 4, 2	SW by S, SW by W, S by W.	·500
„ 8	29·783	63·3	53·7	·583	·73	70·9	58·5	12·4	8, 7, 7	SW by W, SW, SSW.	·012
„ 9	...	...	...	...	...	70·1	55·2	14·9	...	... ...	·000
„ 10	29·837	56·9	51·9	·471	·84	65·7	53·9	11·8	8, 6, 9	W by N, W by S, —	·136
„ 11	29·695	58·9	47·9	·504	·69	67·4	53·4	14·0	9, 8, 4	WSW, SW by W, NW.	·023
„ 12	30·021	58·6	49·0	·499	·72	67·9	46·9	21·0	6, 8, 7	W, NW by N, W by N.	·000
„ 13	29·920	56·3	55·0	·462	·96	65·4	53·0	12·4	10, 10, 10	SW, SW by S, SSW.	·061
„ 14	29·892	64·7	57·0	·611	·77	74·3	54·4	19·9	9, 4, 3	WSW, SW, SW by W.	·051
„ 15	29·853	71·0	62·1	·750	·75	80·4	50·1	30·3	1, 0, 0	SSE, S, SW by S.	·000
„ 16	...	...	...	...	...	77·4	62·1	15·3	...	... ...	·000
„ 17	29·915	62·5	62·1	·568	·98	71·9	60·7	11·2	7, 10, 10	NW by W, NW, NW.	·040
„ 18	29·865	57·8	51·3	·486	·80	68·8	53·7	15·1	4, 10, 10	SW by S, SSW, S.	·171
„ 19	29·787	60·8	53·3	·537	·77	68·7	52·1	16·6	9, 6, 8	SW by W, SW, SW by W.	·073
„ 20	29·817	64·3	52·1	·603	·67	71·9	48·2	23·7	4, 7, 6	S by W, SW by S, S by E.	·004
„ 21	29·825	62·8	54·9	·574	·77	71·8	50·1	21·7	9, 9, 10	ENE, E by S, NE by E.	·000
„ 22	29·722	63·2	53·1	·581	·71	72·3	59·6	12·7	9, 7, 7	ENE, E by N, SE by E.	·000
„ 23	...	...	...	...	...	68·7	59·0	9·7	...	... ...	·176
„ 24	30·161	66·3	59·0	·644	·79	75·3	54·5	20·8	10, 10, 8	—, —, —.	·083
„ 25	30·239	67·6	58·3	·672	·74	76·3	59·2	17·1	10, 0, 1	NE, E by S, SE.	·006
„ 26	30·311	69·5	54·5	·715	·61	78·8	54·3	24·5	1, 0, 0	N, SE by E, SE.	·000
„ 27	30·177	70·7	59·9	·743	·70	80·4	53·8	26·6	0, 9, 10	—, NW, NW by W.	·000
„ 28	30·224	62·6	47·4	·570	·60	72·0	51·1	20·9	5, 1, 2	W by N, WNW, W.	·000
„ 29	30·021	64·3	51·2	·603	·64	75·7	51·5	24·2	2, 4, 3	W by S, W, WSW.	·000
„ 30	...	...	...	...	...	71·8	56·3	15·5	...	... ...	·006
„ 31	29·737	56·3	50·4	·462	·82	66·6	48·2	18·4	9, 10, 10	SW, W by S, —.	·000
Daily Means.	29·931	63·6	54·6	·597	·74	...	...	18·5	...	... ...	1·817

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JULY, 1865.

Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
A.M. 1	20	4	4	2	7	2	3	18	9	6	10	9	3	13	1	10	5	8	6	4	3	6	2	2	1	4	2	4	*	*	*	6·0
2	16	4	3	2	8	3	4	15	7	5	9	6	6	10	1	10	6	7	6	3	2	5	2	2	2	4	3	4				5·5
3	17	5	3	4	10	2	8	15	9	5	9	5	6	10	2	10	2	10	4	2	1	5	4	1	3	4	1	4				5·8
4	17	5	4	2	9	4	11	15	11	5	8	5	7	8	3	10	3	9	4	5	2	6	3	2	2	2	1	7				6·1
5	20	5	4	3	8	5	11	13	10	7	7	5	7	3	1	6	4	7	2	1	2	3	3	2	2	4	2	6				5·5
6	19	5	2	2	10	6	13	15	9	5	9	7	8	5	2	8	4	10	3	1	2	2	5	1	4	4	3	6				6·1
7	19	5	4	3	13	10	16	17	8	10	9	11	5	9	3	11	3	10	3	3	4	3	6	2	2	3	3	9				7·3
8	18	6	5	7	12	7	16	20	12	10	12	13	17	13	7	13	4	12	5	6	5	3	7	1	2	1	3	12				8·9
9	18	6	4	11	14	10	18	23	10	13	11	12	18	17	10	13	3	15	9	11	7	7	2	2	2	2	4	14				10·2
10	20	6	6	14	13	18	22	22	9	11	10	12	18	16	11	18	4	14	11	14	8	6	3	2	5	2	6	12				11·0
11	22	8	5	16	12	15	27	24	12	15	10	12	20	18	14	12	7	15	12	14	12	5	2	3	9	5	8	11				12·3
12	20	7	6	17	13	10	28	28	7	17	9	10	21	17	16	14	6	16	13	16	12	3	3	4	8	8	10	11				12·5
P.M. 1	18	9	7	20	18	9	30	30	9	14	11	11	26	17	16	14	5	17	15	17	12	4	7	5	10	8	10	*				13·7
2	17	8	9	23	15	6	30	30	12	15	12	11	25	20	18	15	4	18	14	19	14	5	5	2	11	8	9					13·9
3	18	9	6	20	16	5	30	29	9	10	12	10	25	20	21	12	4	15	14	19	13	10	4	2	14	7	8					13·4
4	13	7	9	19	17	7	25	29	17	12	15	10	20	20	21	11	7	14	17	15	11	10	4	6	11	7	8					13·5
5	18	10	10	20	17	8	28	25	16	10	15	9	23	20	20	14	9	16	15	15	8	15	5	2	12	8	10					13·8
6	12	10	8	16	13	7	25	20	12	3	14	9	22	18	22	12	8	15	15	15	8	10	4	2	11	7	7					12·0
7	8	11	5	13	12	6	22	18	9	6	15	6	23	16	19	11	5	10	16	12	7	10	2	3	6	7	7					10·5
8	7	10	5	8	9	12	16	14	7	6	10	6	19	13	14	7	5	12	10	8	5	7	4	4	5	3	13					8·8
9	2	6	2	7	8	9	17	13	8	9	7	4	16	9	8	5	6	14	5	4	3	5	2	7	6	4	12					7·3
10	3	6	2	7	8	9	17	12	5	9	3	4	15	6	5	4	6	12	4	4	2	5	2	4	5	2	12					6·4
11	3	6	2	9	7	3	18	13	7	7	5	5	15	4	6	4	6	13	3	3	4	3	1	3	6	3	12					6·3
12	6	4	1	6	6	2	14	10	7	8	7	4	12	2	10	4	7	5	4	1	3	1	2	3	4	3	5					5·2
Total Daily Movement.	348	162	116	251	275	175	449	468	231	218	239	196	377	304	251	244	123	294	210	212	150	139	84	67	143	110	159	100				9·2

* Anemometer clock undergoing repair.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1865. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Reduced to mean of day. Temperature of Air.	Calculated. Dew Point.	Calculated. Relative Humidity.	Calculated. Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Temperature of Air. Minimum, read at 9·30 A.M.	Temperature of Air. Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Aug. 1	29·752	53·9	44·7	·73	·426	63·1	49·3	13·8	10, 7, 8	NW, SW, W.	0·860
" 2	29·650	52·3	46·5	·82	·404	62·3	45·3	17·0	7, 9, 10	SW by W, SW, SW by W.	·010
" 3	29·733	48·5	48·3	·84	·354	61·4	43·5	17·9	10, 8, 10	SW, W by S, SW.	·592
" 4	29·976	55·0	43·4	·67	·442	64·5	45·7	18·8	10, 7, 1	NNW, N by W, N by W.	·208
" 5	30·074	61·2	45·4	·58	·544	69 9	42·6	27·3	0, 4, 8	—, W, WSW.	·005
" 6	...	...	...	...	...	69·7	51·4	18·3	...	... ...	·003
" 7	29·816	63·5	58·2	·84	·587	72·8	58·2	14·6	9, 4, 10	W by S, WSW, W.	·015
" 8	29·973	60·3	52·2	·76	·528	67·6	51·4	16·2	4, 9, 8	NW, NW by N, NNW.	·025
" 9	29·871	63·9	51·4	·65	·595	73·6	47·7	25·9	1, 6, 8	—, SW by S, S by W.	·000
" 10	29·703	61·7	55·1	·80	·553	73·1	51·4	21·7	9, 8, 10	SW by S, S, S.	·000
" 11	29·551	60·9	59·7	·96	·539	67·8	57·5	10·3	9, 10, 9	S, S by E, S by W.	1·014
" 12	29·739	59·4	54·6	·85	·512	67·6	51·2	16·4	8, 10, 10	S, S by W, —.	·040
" 13	...	...	...	...	...	68·7	53·8	14·9	...	... ...	·026
" 14	29·737	59·5	54·9	·86	·514	69·4	53·9	15·5	9, 8, 9	SSE, S by W, S by W.	·062
" 15	29·538	60·6	60·1	·98	·533	66·5	54·6	11·9	10, 10, 9	SW by W, SW, SSW.	·159
" 16	29·694	59·5	50·7	·74	·514	65·9	53·9	12·0	7, 5, —	SW, WSW, W by S.	·017
" 17	29·795	58·0	50·0	·76	·489	64·8	53·1	11·7	6, 8, 9	W by N, WNW, W by S.	·106
" 18	29·849	59·1	49·9	·73	·507	68·1	54·4	13·7	6, 8, 9	NW by N, N by W, NW by N	
" 19	29·922	61·9	51·0	·69	·557	70·0	45·8	24·2	0, 3, 4	—, E by N, E by S.	·007
" 20	...	...	...	...	...	71·8	52·3	19·5	...	... ...	·000
" 21	29·738	63·2	54·1	·74	·581	72·0	54·2	17·8	5, 3, 7	W by N, W by S, W by S.	·238
" 22	29·688	64·5	51·8	·65	·607	72·0	55·6	16·4	0, 5, 7	WNW, NW by N, —.	·000
" 23	29·475	59·3	57·9	·95	·511	63·3	52·3	11·0	10, 10, 10	E, E by N, WSW.	·166
" 24	29·796	65·4	51·9	·64	·625	71·6	54·8	16·8	4, 3, 3	WSW, NW by W, S by W.	·741
" 25	30·069	58·4	55·1	·89	·496	67·8	53·6	14·2	8, 9, 2	NNE, ENE, NE by N.	·000
" 26	30·254	62·3	57·2	·84	·564	72·6	52·4	20·2	10, 2, 1	NE by N, ENE, E by S.	·001
" 27	...	...	...	...	...	75·7	46·5	29·2	...	... ...	·000
" 28	29·826	63·0	61·0	·94	·578	69·3	55·6	13·7	10, 10, 9	SW, SW, WSW.	·043
" 29	30·030	56·4	46·7	·72	·464	63 6	52·8	10·8	7, 8, 7	NNW, NE, N.	·004
" 30	30·288	58·5	46·8	·67	·497	66·8	49·3	17·5	2, 4, 3	NW by N, N, NNW.	·000
" 31	30·168	59·7	55·5	·87	·518	66·0	45·9	20·1	4, 10, 10	W by N, SW, WNW.	·000
Daily Means.	29·841	59·6	52·2	·78	·520	...	...	17·1	...	...	4·342

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—August, 1865.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour. A.M. 12	*	5	1	18	1	6	11		3	3	9	4	11	7	9	6	7	15	3	1		7	1	6	5	4	1	1	5	4	0	5·3
1		6	2	15	1	4	9	148	1	2	2	5	14	6	7	9	7	14	2	1		4	2	6	4	6	1	2	3	4	1	5·0
2		5	2	12	1	2	7		2	2	1	5	12	6	8	6	7	13	1	1		5	3	8	2	4	1	3	5	8	2	4·6
3		6	8	12	1	4	10		2	1	3	6	5	9	10	8	6	12	2	1		4	3	8	6	3	1	3	8	2	2	5·0
4		8	7	13	1	3	10		1	1	2	3	5	10	14	6	10	13	1	0		6	6	6	9	4	1	1	7	2	3	5·5
5		8	5	10	2	4	10		1	2	2	4	10	11	17	6	9	13	1	1		4	8	8	9	5	1	3	8	4	2	6·0
6		9	5	11	2	6	10		1	1	2	5	15	15	20	8	11	13	2	1		5	8	8	11	5	1	2	9	4	5	7·0
7		14	5	12	4	9	13		1	2	9	9	16	19	22	13	13	15	2	3		5	10	9	11	5	1	3	10	8	5	8·8
8		13	4	13	2	14	13		2	4	11	13	19	16	20	15	17	16	2	3		5	11	8	14	4	1	4	10	12	7	9·7
9		12	5	13	2	12	13		2	6	15	13	20	20	22	15	17	17	3	3		6	17	8	14	4	2	10	14	13	4	10·8
10		12	9	12	6	13	13	12	5	7	17	17	18	22	24	12	17	15	2		15	7	15	10	10	7	2	14	12	12	*	12·0
11		10	8	13	6	17	9	6	5	9	21	16	22	19	24	16	19	14	6		12	5	15	8	10	7	3	12	14	14		12·0
P.M. 12	11	14	14	15	6	16	10	10	3	6	17	9	22	20	24	17	16	12	4		8	5	12	9	9	8	3	14	9	10		11·5
1	12	16	11	12	9	20	13	9	4	5	17	15	21	13	20	19	16	13	2		12	5	9	8	11	6	4	17	10	9		11·7
2	11	18	8	10	6	20		10	4	10	15	15	21	12	20	19	20	10	4		13	5	11	7	7	5	6	16	12	6		11·5
3	11	16	14	11	7	17		8	3	15	15	15	21	11	20	15	23	9	4		12	3	8	4	15	3	7	16	9	6		11·4
4	11	7	9	10	7	20		8	9	14	18	16	20	12	20	18	20	9	5		10	2	3	9	13	6	7	14	10	5		11·1
5	13	4	9	9	5	18		7	9	6	18	12	17	9	20	14	17	7	5		7	1	5	9	10	6	7	10	7	2		9·4
6	10	4	10	3	1	13		3	6	3	18	12	14	9	19	11	18	4	5		12	7	5	6	7	5	2	11	5	1		8·0
7	8	4	10	2	1	13		3	7	5	16	10	9	7	16	11	16	2	4		11	3	4	4	7	5	1	9	2	1		6·8
8	9	3	18	1	8	13		1	4	2	15	5	7	7	15	9	17	2	2		7	2	3	8	6	2	1	7	4	2		6·1
9	7	4	18	2	8	13		1	5	6	10	7	7	5	13	10	19	3	2		5	2	3	2	7	2	2	5	4	2		6·0
10	10	1	14	2	5	11		2	3	5	8	11	11	6	13	10	17	2	2	210	5	2	5	4	5	1	2	5	4	2		6·0
11	7	1	13	1	6	11		1	3	8	6	10	8	5	8	9	17	2	3		3	2	5	4	5	1	1	5	5	3		5·5
12																																
Total Daily Movement.	120	200	194	227	98	279	380		86	125	267	237	345	276	405	282	356	245	69	357		102	172	161	207	108	59	187	186	128		8·2

* Anemometer clock out of order.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1865.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Tension of Vapour.	Relative Humidity.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°	inch.		°	°	°	0—10		inches.
Sept. 1	30·118	60·7	48·0	·585	·65	69·7	55·3	14·4	7, 2, 2	WNW, W, W by N.	0·000
,, 2	30·161	69·3	56·1	·710	·65	77·4	55·9	21·5	7, 4, 2	NW by N, NW, NW.	·000
,, 3	...	...	...	...	...	74·8	55·5	19·3	...	... ...	·000
,, 4	30·109	69·5	59·9	·715	·73	77·8	53·3	24·5	0, 5, 2	—, S by W, WSW.	·000
,, 5	30·142	66·8	57·2	·654	·73	73·9	52·7	21·2	6, 2, 4	SW by W, SE, WSW.	·000
,, 6	30·128	66·0	58·4	·638	·78	74·7	51·3	23·4	0, 2, 0	W by S, SW, SW.	·000
,, 7	30·020	70·2	62·7	·781	·78	79·6	54·4	25·2	0, 1, 3	SW, S, SW.	·000
,, 8	29·914	72·9	61·6	·798	·69	80·8	54·7	26·1	0, 1, 0	SW, —, SW by W.	·000
,, 9	30·075	63·4	53·9	·585	·73	71·5	59·5	12·0	1, 3, 5	SW by S, SW, SW by S.	·115
,, 10	...	...	...	...	...	73·9	58·2	15·7	...	... ...	·000
,, 11	30·312	66·4	60·1	·647	·81	73·8	63·1	10·7	10, 7, 8	WSW, SW by W, W by S.	·000
,, 12	30·398	66·3	57·6	·644	·75	74·3	57·5	16·8	7, 6, 7	—, —, —,	·000
,, 13	30·295	68·6	58·6	·694	·72	76·8	57·8	19·0	8, 0, 0	SW by S, SW by S, —.	·000
,, 14	30·239	68·1	53·9	·683	·62	77·4	51·1	26·3	0, 0, 0	E, E by S, SE by E.	·000
,, 15	30·169	72·2	54·0	·780	·55	80·7	57·0	23·7	0, 0, 0	SSE, SE by S, SE.	·000
,, 16	30·137	69·6	60·8	.717	·75	79·8	53·5	26·3	7, 4, 8	W by N, S, —.	·000
,, 17	...	...	...	...	...	74·5	56·0	18·5	...	... ...	·000
,, 18	30·413	65·0	55·6	·617	·73	73·7	50·7	23·0	0, 2, 0	—, NE by E, NE.	·000
,, 19	30·360	62·3	56·7	·564	·83	72·3	50·4	21·9	6, 2, 0	—, E by N, ENE.	·000
,, 20	30·089	65·7	57·1	·631	·75	76·4	51·6	24·8	3, 0, 0	—, SW, S by W.	·000
,, 21	30·206	54·9	50·8	·441	·87	62·0	53·2	8·8	10, 7, 9	NNE, NE by N, NE by N.	·350
,, 22	30·360	56·2	47·6	·460	·75	63·2	53·6	9·6	1, 7, 3	NE, NE by N, NE.	·003
,, 23	30·451	56·9	47·6	·471	·73	64·3	39·5	24·8	2, 1, 2	E by N, NE by E, NE by E.	·000
,, 24	...	...	...	...	...	67·7	52·6	15·1	...	... ...	·000
,, 25	30·377	60·5	49·7	·532	·69	71 6	47·0	24·6	6, 0, 0	ENE, E by N, E by N.	·000
,, 26	30·220	63·6	50·1	·589	·64	75·3	49·8	25·5	4, 0, 0	E, SE, E by N.	·000
,, 27	30·084	64·8	49·2	·613	·59	76·2	44·8	31·4	5, 0, 3	NNE, E by N, E by S.	·000
,, 28	30·176	63·4	51·4	·585	·67	69·0	42·7	26·3	0, 0, 7	NNE, NE by N, NE by N.	·000
,, 29	30·203	56.6	51·3	·467	·83	64·1	46·6	17·5	10, 7, 8	NE by E, ENE, E by N.	·000
,, 30	30·087	56·6	50·7	·467	·82	64·9	47·6	17·3	3, 4, 9	NE, ENE, E.	·000
Daily Means.	30·201	64·5	54·6	·614	·72	...	...	20·5	...		0·468

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—SEPTEMBER, 1865.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour. 12	*	*	*	*	*	*	*	*	8	11	10	2	2	1	4	2	3	1	1	2	2	9	2	10	5	4	4	1	8	5	4·4
A.M. 1									5	8	10	2	3	1	2	2	1	1	2	2	4	10	2	11	5	1	4	2	7	4	4·0
2									6	8	10	1	4	1	3	2	1	1	0	3	9	10	1	9	5	3	3	2	3	3	4·0
3									7	6	11	1	3	0	4	2	1	1	0	3	7	7	1	9	3	3	2	1	2	1	3·4
4									5	8	10	1	3	1	4	2	3	2	2	7	6	10	1	9	3	6	2	2	2	1	4·1
5									5	6	8	1	2	1	3	1	3	2	1	7	7	11	2	12	5	9	2	2	3	1	4·3
6									8	7	10	2	1	1	3	3	1	1	1	3	10	10	4	14	8	10	3	2	2	3	4·9
7									8	7	9	1	2	1	5	3	5	3	2	2	10	13	2	16	8	6	2	4	3	6	5·4
8									6	8	12	1	5	2	5	3	6	2	4	3	10	10	4	17	4	3	3	4	5	9	5·7
9									12	8	8	3	5	1	7	2	8	3	3	2	12	9	11	14	2	9	4	9	10	10	6·9
10									12	20	8	5	4	12	8	5	10	2	13	3	15	12	14	16	8	10	5	10	10	11	9·7
11								12	11	22	7	3	8	11	9	7	10	5	14	6	14	13	13	19	14	12	7	10	10	10	10·7
12								15	13	18	10	4	8	11	13	7	7	6	15	9	18	17	14	20	18	15	13	12	14	11	12·5
P.M. 1								17	14	17	10	2	7	11	13	7	8	7	15	13	14	13	16	17	20	15	18	11	14	11	12·6
2								18	15	19	11	4	6	12	12	6	8	7	16	11	15	15	16	18	20	12	18	11	15	10	12·8
3								18	15	17	9	7	5	13	11	4	8	6	17	13	17	8	15	17	23	12	13	9	13	9	12·1
4								17	16	19	11	4	4	8	10	6	9	7	14	13	15	7	13	18	18	15	10	6	13	8	11·4
5								12	14	17	10	3	4	12	8	4	5	5	11	6	10	7	9	12	13	9	8	7	6	7	8·6
6								14	12	15	7	4	6	8	4	7	2	6	13	3	12	6	5	10	10	8	7	10	3	8	7·8
7								11	13	14	7	6	4	11	2	6	1	6	10	5	10	6	6	10	14	9	7	10	3	7	7·7
8								9	12	14	4	1	2	10	4	3	4	5	10	5	12	4	9	10	9	5	2	9	2	3	6·4
9								8	12	13	4	2	0	6	5	3	3	4	8	3	10	4	6	10	9	3	1	10	2	2	5·6
10								6	11	12	3	2	2	7	3	2	2	2	5	3	9	3	7	8	7	3	2	12	2	5	5·1
11								6	11	8	4	1	0	5	3	1	2	1	2	2	7	2	9	7	3	4	1	8	3	5	4·1
12																															
Total Daily Movement.								163	251	302	203	63	90	147	145	90	111	86	179	129	255	216	182	313	234	186	141	164	155	150	7·3

* Anemometer stand undergoing repair.

OPINIONS ON EPIDEMICS AND EPIZOOTICS.

In our September number we published a paper on the "Cattle Plague and Scientific Investigation," since which, up to the date of appointing a Royal Commission, at the beginning of October, the Government has indulged in much restrictive legislation, without doing anything to test the accuracy of the theories which its veterinary advisers have propounded. We believe that the Privy Council have collected a vast quantity of information of a miscellaneous sort; but one obvious duty of that body, from the commencement of its action in reference to the cattle plague, was to organize an inquiry into the probable origin of the disorder. If it could be proved to be simply and purely an importation from Russia, and only to appear in this country after germs of the disease had been distributed through the agency of imported animals, and if it could be further proved that restrictive measures could prevent its spread, then the only limit to such measures ought to be the practicability of their execution. This theory is acted upon in some parts of the Continent, where the medical authorities appear to know as little about the matter as our own, and where despotic principles of Government preclude all consideration of individual liberty and right. The Earl of Clarendon, in a speech at Watford, after alluding to the restrictive measures which the Privy Council was trying to enforce, said, "I own that if we had lived in a despotic country very different measures would have been taken. Every suspected district would have had a cordon of soldiers placed round it, every animal would have been killed, and every man suspected of violating the regulations would have been put into prison. So stringent are the regulations in Germany, that only a few days ago a stuffed wolf was prevented from crossing the frontier, for fear of spreading the contagion!" This is the sort of proceeding which the English Government is invited to adopt by its veterinary advisers, and it only stops short of such monstrous absurdities because the temper of the people would not allow them to be carried out. Well might Sir E. Bulwer Lytton exclaim, "It is not by indiscriminate slaughter, it is not by adding famine to pestilence, that a Government can be hailed as our protector, or science received as our guide."

If the reader will refer to our previous article in the September number he may see the strong resemblance between the notions now entertained by ultra-contagionists, and partially adopted by the Government, and those notions concerning cholera, which raged like a plague, amongst the College of Physicians in 1831. Professor Simonds, the Government

adviser, is an ultra-contagionist, but the most violent and unphilosophical of the school is Professor Gamgee, whose assertions are so reckless, and whose statements are so extravagant, as to remove him from the category of calm scientific inquirers. He makes contagion a hobby, and he rides it to death. Dr. Lankester was imprudent enough, at the Social Science Congress, to support the Gamgee hypothesis, and to indulge in a general theory of contagious disorders; and he put, in perhaps the most scientific form such notions admit of, the current belief of those who think diseases can be suppressed by orders of the Privy Council, Acts of Parliament, and police. The learned doctor condemns an imaginary doctrine that diseases have "a spontaneous origin in dirt," and he thus proceeds to develop his own views:—"Take," he says, "for example, the small-pox. In order to propagate this disease, there must be, first, the poison matter from a small-pox pustule; secondly, a medium of conveyance—either the point of a lancet, or an atmosphere to convey the poisonous germs; and thirdly, there must be a person predisposed to take it."

Now in this brief paragraph we have a succession of positive assertions, some of which cannot be proved. We pass over for the moment the question of whether they are true or not. If true, they still exist only as *conjectures*, and require the verification which full and careful inquiry alone can give. If no case of small-pox can occur without its being excited by the specific poison found in a small-pox pustule, either the laws of nature must have changed, or a specific disease of small-pox must have been created and sent perfect into the world at some past and unknown time. We have heard of a Professor who is of opinion that species of diseases were created, as well as species of animals, and that all existing diseases, and all existing animals, are lineal descendants, with little variation from the primitive individual specimen. Dr. Lankester does not tell us, in so many words, that he shares this extraordinary faith; but his dictum amounts implicitly to this: that all past small-pox, all now existing, and all that is to come, was, is, and will be the progeny and descendant of a primitive specially-created case.

We repeat that we do not now discuss whether this theory be true or false; but we are justified in saying that it is not proved, and that those who hold it are not entitled to speak of it as if it were an ascertained fact.

It is probable or possible that the atmosphere may convey the germs of small-pox, as Dr. Lankester declares; but this again is not known. In the case of vaccination or inoculation, the lancet of the practitioner conveys into the blood of the patient certain corpuscles or cells of morbific matter in an

active state, but whether such cells,* or any portion of them, floating about in the air, and taken into the lungs, or swallowed, or permitted to adhere to the skin, is a real cause of the propagation of small-pox, no microscopist has yet ascertained.

The probability of a scientific theory in any given state of knowledge does not offer the slightest excuse for abstaining from a rigid process of inquiry and verification, and those accurate thinkers who consider Dr. Lankester's hypothesis may be right, will not fail to perceive the want of decisive evidence to support it.

When Dr. Lankester asserts that small-pox can be communicated to suitable individuals by the process of inoculation, he states a fact of which the proof is abundant; but when he takes small-pox as a type of epidemic diseases, and affirms that they can *only* arise by the action of specific poisons, he oversteps the limits of that which is known, and by implication affirms divers theories open to doubt. We have already shown that such a philosophy virtually affirms the original creation of specific diseases, and it also affirms other theories which, if less startling, ought not to be accepted lightly. In a natural and healthy condition we find a continual formation of corpuscles, or cells, and such formations are by no means sharply distinguished from all the products of disease. Causes, such as temperature, moisture, dryness, the presence of putrefying matter introduced into the system from extraneous sources, *may* determine the production of morbid cells by simple variation, from healthy cells, and without any hereditary descent from other morbid cells of any particular kind. This possibility is denied by those who account for diseases by presuming them to result exclusively from *specific poisons*, themselves the product of previous disease of the same species.

We do not offer any opinion as to the extent to which physical and chemical agencies can modify healthy actions, so as to convert them into morbid actions. No one will deny that such an influence may be exerted to a large extent, and no one is entitled to lay down any limits of such action, except those which result from a rigid application of reasoning to a sufficient group of ascertained facts.

In the present state of science a certain class of diseases are not unreasonably supposed to result from something like an action of fermentation, and are hence called *zymotic*. Now, the researches of microscopists, and especially of M. Pasteur, lead to the belief that very minute organisms, more or less

* In the wide sense now given to the term "cell," it may be used without expressing any precise idea of its structure.

resembling yeast, and many of them taking the beaded, or bacterium form, are capable of setting up a variety of fermentations, each developing particular products. M. Davaine has apparently traced a splenic disease in sheep and other animals to an organism of this sort, and the counter experiments seem to show, not that he was wrong, but that his opponents were not operating with the particular organism of which he spoke. Any small independent body, whether having distinct walls or not, which contains or consists wholly or partly of germinal matter, capable, under appropriate conditions, of multiplying by reproduction, may be conveniently called a cell. Such cells may be able to live and multiply in more forms than one. Indeed, as we proceed downwards in the chain of life, the tendency to variation appears decidedly to increase. If, therefore, it is thought probable that zymotic disorders can arise from cells of a particular sort floating in the atmosphere, we should not be justified in asserting that wherever and whenever such cells thrive and germinate in a living being, they must produce one constant type of disease. The proof that a small-pox cell, taken from a pustule, and introduced into the blood of a fit subject, reproduces in him the same disease of small-pox, is not tantamount to a proof that germs from small-pox cells, if such exist, floating for an indefinite time in the air, must either reproduce small-pox, or exert no morbid action at all. We have no proof that germs of disease admit of no variation in their development, whatever may be the conditions under which they are placed. We neither affirm nor deny the accuracy of different hypotheses; our object is to explain, and, if possible, to enforce something like scientific accuracy in reasoning upon these subjects, and to put our readers upon their guard against the pervading error of considering things proved that in reality are only surmised.

In reference to those opinions concerning the cattle disease which bear a strong family likeness to similar opinions concerning other diseases, now known to have been nothing better than the offspring of fear and superstition—it is necessary to determine the special kind of test to which they should be subjected. In the first place, the importation theory should be cautiously sifted. In every case in which it is assumed that the disease was caught through contagion, proof should be demanded, first, that the alleged circumstances under which the contagion is stated to have operated did really exist; and, secondly, that such circumstances were really competent to produce the effect. In one case reported in the daily papers, the only mode of supporting the importation and contagion theory was by presuming that the poison matter *might* have

been dropped by some animals on a public road, and *might* have been picked up by some other animals ten days afterwards. In other instances it has been presumed that small quantities of the poison may have been carried away by the boots of a grazier, by the skin of a sheep dog, or the clothes of anybody who went within a few yards of a sick cow, and may by some sort of contact with healthy animals have infected them. Now, no presumption, however well founded, that the cattle disease is highly contagious, can make it reasonable to impute to it such a wonderful degree of contagious power, without multiplied observation and judicious experiment, testing and verifying every particular assertion. A certain number of cases seem to favour the importation theory; but even these have not been critically examined. In a multitude of other cases the importation theory is not evidenced at all. It *may* be true, but it has been assumed to be so, first, because it was the fashion of the hour; and, secondly, because particular doctors did not know how else to account for its appearance, and felt a professional dislike to frankly confessing that they knew no more about the matter than the cows themselves.

Those familiar with microscopic inquiries will place no limits to the smallness of the portions of matter that may generate disease. A single bacterium, of the sort described by M. Davaine, obtaining access to the blood of a living animal, appears capable of growth and reproduction, to such an extent as to occasion its death in a few days. The size of such a bacterium and its weight are both infinitesimal, and other germs of disease may be equally small or much smaller. But if it be admitted that M. Davaine's bacteriums cause splenic disease, millions of them might fly about in the air, or attach themselves to cattle, or be swallowed, or inhaled before one contrived to get into the circulatory system in contact with corpuscles of blood. The ultra-contagionists have to show not only the presence and diffusion of their poisons, but also the manner in which such poisons can make an effective entry into the system. Many poisons are only dangerous when administered in a particular way.

The Privy Council has been the death of a great number of animals which might otherwise have been cured. At the Sanatorium meeting, Mr. Guerrier (described as an extensive cattle salesman) stated that a cargo of 108 foreign animals arrived at Harwich, and one of them was suffering from the malady and died. The whole of the remainder were perfectly healthy, and were declared so by the inspector. These were killed and sent to London, while ten others consigned to another party were kept in quarantine and remained healthy. These facts, as Mr. Guerrier said, clearly showed either that

the disease of which the one died was not the rinderpest, or else that the rinderpest was not so infectious as it was represented. It is very important that we should be able to form an estimate of the number of curable animals that have died of the Privy Council, and of the loss occasioned by stopping cattle fairs, etc. Let us also study the other side of the account, and try to find out what the so-called preventive measures have been really worth. That they cannot, under the most favourable probabilities, be estimated as worth much, is rendered probable by some Dutch statistics supplied by Mr. Caird, according to which, out of 3319 animals attacked, 1169 died, 674 were slaughtered, 717 recovered, and the remainder were under treatment. "In proportion," he says, "to the whole number of cattle in the country less than three in every thousand have been attacked by the disease, and not two in a thousand have perished." If our Privy Council and the veterinary surgeons have prevented some cattle from being infected, they have killed numbers which might, according to Dutch experience, have been cured. On which side does the balance lie?

Many people think that they solve the practical difficulty of these cases by violently adopting measures called precautions, on the plea that "it is best to be on the safe side." There may not, however, be a "safe side," but simply a choice of evils. The Government restriction mode of procedure infallibly does much harm, and all that its best friends can expect is to demonstrate that the harm thus done is more than counterbalanced by the good achieved in arresting the disease. We are yet without data from which we can compute either the amount of mischief occasioned, or prevented by Privy Council action. The former is certainly very great, and unless the latter is greater, the balance will be on the wrong side. At a meeting of the Sanatorium Committee of the Corporation of London, which took place on the 13th of October, Mr. Game mentioned a case in which some cows were condemned by the Government inspector, but as the slaughterman could not come at the moment, medical means were adopted and the animals cured instead of killed. Mr. Rudkin mentioned another case in which thirty cows were condemned, and after that twenty-four of them were cured. Mr. Caird likewise tells that in Holland it is found that under a "rational treatment" 25 per cent. of the cows afflicted with the rinderpest have recovered, and he adds, "The most successful treatment is said to have been by homœopathy. This has been practised by two Belgian practitioners, who volunteered their services to the Dutch government. By them 50 per cent. of the animals which had been sick had been cured, and out of

148 sound animals treated by them with preventive medicines, and placed in contact with diseased cattle, not more than four had taken the disease.*

Such statements tend to the belief that the greatest attention ought to be paid to any fact that can throw light upon the causes that have facilitated the attack of the disease in some cases, and prevented it in others. Hitherto the doctors have not obtained the slightest clue to why some cows on a farm have been infected and died, while others, apparently similarly circumstanced, have escaped. It has been the custom to make the most of every case of attack, and to pay little attention to the instances in which the poison, whatever it may be, failed to operate.

Let us suppose for one moment that the violent hypotheses concerning the cattle disease were accepted, and that the continental plan of destroying all cattle found in the vicinity of an infected cow, and of cutting off their attendants from all intercourse with the outer world, except what can take place by periodically tossing them something to eat, was admitted to be the best. It would follow that the only plan of staying the pestilence would be one of wholesale destruction of animals, and quarantine imprisonment of all human beings who had come near them. But why restrict this benevolent action to cattle? If a man catches a disease of this class, and every hour that he lives he scatters far and wide through the atmosphere germs of poison that must kill scores, or it may be thousands, what ought to be done with him? A hospital would evidently be a mistake, and leaving him at home still worse. If he and all his neighbours are not to be killed like the cows, which pseudo-science might recommend, at any rate all infected and suspected persons ought to be securely bottled up in some receptacle capable of imprisoning the disease. Will our glass manufacturers turn their attention to Gamgee-Lankester bottles, with admirably-ground stoppers, in which the afflicted may be immured?

One of the beneficial results of modern science has been the diminution of fear in the treatment of disease. It has been shown that if persons sick of contagious disorders can be placed under healthy conditions of ventilation, cleanliness, light, etc., attending upon them does not involve serious risk. In former ages the advent of the plague produced an epidemic terror as bad as, or worse than the disease, and to this day, in the East a similar state of mind prevails. Even at Smyrna, during the recent outbreak of cholera, hotel keepers refused to receive guests, all the people, doctors included, were afraid to attend the sick, and misery was multiplied a hundredfold, because terror assumed unrestrained command. It is to this

* Letter to the *Times*, 17th Oct.

condition the ultra-contagionist doctors would bring us back, and if they are the cause of a dangerous epidemic terror, why, on their own theory, should they not be debarred from all intercourse with their fellow men?

Theories of epidemics affect the whole life of a nation, and hence it is of the highest importance to know whether they are right or wrong. In dealing, or attempting to deal, with the cattle disorder the Privy Council most seriously affects great interests, as well as infringes private liberty in a way that can only be excused by an amount of proof of the accuracy of their ideas which certainly does not at present exist. They have thrown the foreign cattle trade into deplorable confusion, and they are obstructing the home trade in a very serious way. We copy the following statistics of the cattle trade from the *Morning Star*:—

"The increase in each class of beasts imported is large and constantly progressive. For the months ended 31st August, 1863, 1864, and 1865, respectively, the numbers of oxen, bulls, and cows imported were 14,279, 18,261, and 27,207; of calves, 6,726, 5,477, and 8,078; of sheep and lambs, 66,610, 67,360, and 105,365; of swine and hogs, 4,132, 11,021, and 15,137. For the eight months ended 31st August, 1863, 1864, and 1865, respectively, the numbers imported were, of oxen, bulls, and cows, 45,361, 82,447, and 119, 323; of calves, 21,863, 29,373, and 35,553; of sheep and lambs, 214,950, 256,694, and 427,439; of swine and hogs, 6,679, 37,630, and 64,559. Mr. Henley's 'drop' he stated at about 138,000 head of cattle imported, but according to the present rate of importation the figures should have been about 160,000 head of oxen, bulls, and cows; and if the other descriptions of live stock be taken into account, the number of heads imported will amount at the present rate to above 860,000 head per annum."

Such a trade as this is a most serious matter in reference to the difficult question of feeding an enormous population, and when in addition to the injury done to the foreign trade we read of cattle fairs being stopped, and learn that arrangements for breeding fresh stock are interrupted to a great extent by Privy Council legislation, it is time to inquire very seriously whether Government intervention is not likely to prove much more mischievous than the disease it is intended to stop. If State meddling raises the price of meat two or three pence in the pound, it will indirectly kill multitudes of human beings, and the survivors may at last have the consolation of learning that the notions of the doctors were founded in mistake.

THE LUNAR MARE SERENITATIS.—DOUBLE STARS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

We come now to a grey level of very interesting character, as well as peculiarly well situated for study, the *Mare Serenitatis* (lettered E in our map). It is of an approximately circular form, extending 442 miles in a N. and S. direction, and 423 from E. to W.; its longest axis lying from SW. to NE. Some foreshortening of course results from its N. latitude, but not sufficient to distort it materially; the telescopic view, however, gives but little idea of the convexity of so considerable an area upon the comparatively small lunar globe. Its outline is not much indented, and is more distinctly marked out than in the majority of these plains: its circumference, including bays, equals about 1840 miles, three-fourths of which consist of the cliffs of *Hæmus, Taurus, Caucasus,* and the *Apennines.* Broad passages unite it on the S. with the *Mare Tranquillitatis,* on the N. with the *Lacus Somniorum,* and on the E. with the *Palus Putredinis.* When the *M. Tranquillitatis* and *L. Somniorum* lie with it on the same terminator, it is evidently on a lower level than the other two; and this is confirmed by the circumstance that the slopes of nearly all its mountain borders are much more steep on their inner than their outer sides, and when there is any perceptible difference in the slopes of the low ridges in the interior, it is always in the same direction. This great plain presents in many phases a fine telescopic object, and when the terminator passes through the E. edge, the whole may be seen at once in beautiful projection. I have noticed it thus some hours before quadrature, but, of course, libration makes a material difference in all such epochs. The outer edge, on nearly every side, for a breadth of 28 to 83 miles, shows usually a dark uniform grey, of 1½° to 2° of reflective power. The whole interior, comprising nearly two-thirds of the entire area, exhibits at the Full Moon, according to B. and M., a beautiful clear uniform light green of 3°, which, as they state, was remarked neither by Schröter nor Lohrmann, and which they freely admit may be so much matter of "personal chromatic equation" (to borrow an expression of later invention), that they should not feel surprise at its not being perceived by others: they are well assured that the contrast between the light of the plain and its border is a difference not merely in degree but in kind; but they allow that it is not easy to be satisfied of it, and that it is chiefly discoverable by comparison with other levels of similar brightness, and only

for two or three days before and after the Full Moon. I have never succeeded in seeing it decidedly green. My attention having been called to the point, I can detect some difference in the tint from that of other plains, but the contrast is not great: I should perhaps call the hue, as it appears to me, a greenish yellow. The boundary between the lighter centre and its deeper fringe is very distinct, especially to the S., where it passes alike over plain and ridge: in other directions it coincides with slight elevations.

The plain is nearly equally divided by an almost straight whitish streak, with a breadth of about 12 or 14 miles, a luminosity of 4° to 4½°, and a direction not much differing from that of the meridian. It becomes less conspicuous as the terminator approaches it, and vanishes entirely before the lunar sunset, exhibiting not the slightest elevation or depression, though concurring in some places with the direction of slight ridges, which Schr. mistook as an indication of height throughout. Our guides remark that in so favourable a position banks of 60 or even 40 feet might be detected, though scarcely capable of delineation; and that every elevation, however insignificant, or of whatever tint, becomes more distinguishable in the immediate vicinity of the terminator; while on the contrary this, and the other streaks in general, comport themselves in the very reverse way; there being not one on the whole lunar surface that is perceptible in that situation.

This beautiful expanse will afford to the observer an excellent opportunity of studying the more familiar characteristics of these grey plains. He will not indeed meet with many of those insulated mountains and craters which give so great a charm to the scenery of the *M. Crisium*, the *M. Imbrium*, and others, nor will he find those roughened tracts which characterize the neighbouring *Lacus Somniorum* and similar regions. But the broad sweep of undisturbed level can scarcely anywhere be studied to greater advantage, and the low ridges which may possibly have a greater significance in selenology than might at first have been supposed, are here very clearly developed. A small bright crater named *Taquet*, between *Menelaus* (15) and the *Promontorium Acherusia* (previously described), is the starting point of the ridge-system of the plain; and we have here an exemplification of a fact to which Schr. has repeatedly invited our attention—that these low banks form lines of communication between objects of more apparent importance. Though in many of them no such arrangement can be made out, yet the instances are innumerable in which they are found to connect distant craters or headlands, or to serve as the bases of rocks or small hills, much resembling, if so homely an illustration may be permitted, the

subterranean galleries by which the common mole unites his more serious and massive upheavings. Schr. was in fact disposed to refer their origin to the working of an elastic force beneath the surface of the moon, which, in regions where the crust of the globe was of great tenacity, and offered a proportionate resistance, would thus slightly elevate it in making its way laterally till it reached a more penetrable spot, where it would protrude a lofty mountain mass, or explode in a crater. Whatever may be thought of the probability of the explanation, the fact is unquestionable that these ridges generally begin and end, like terrestrial highways, in something of more importance than themselves, and that this is of such continual occurrence in every part of the moon that we can hardly be mistaken in ascribing it to the operation of some general law. In the plain which we are now studying, the most remarkable of these ridges lies not far from its W. side, and in a general sense parallel to it. Including its curvatures it measures nearly 500 miles in length, while it is but 400 or 500 feet high towards its S. extremity, and rises only to 700 feet in one part near its opposite end, its slope never exceeding 10°, and its base of 7 miles, as Schr. observes, giving a proportion of only $\frac{1}{43}$rd for its altitude. In one place it bears a minute crater, precisely where a similar ridge runs into it, in accordance with Schröter's hypothesis. B. and M. have not drawn attention to the very curious appearance which this great *serpent* exhibits near the terminator. This has been well though rudely delineated by its discoverer Schr., who points out its connection with the ring of *Posidonius* at its N. extremity. The student will find it worth watching for, and will notice how its strong dark shadow close to the terminator demonstrates the visibility of very slight elevations in that position. In the E. side of the plain the ridges are less considerable, and B. and M. remark that in no portion of the lunar hemisphere is the terminator of so regular an elliptical curve as when it passes through part of this district.

A good many craters lie scattered throughout the level, but generally of minute dimensions. The most important by far is *Bessel,* which though but 14 miles in diameter, is the most conspicuous object in the interior, lying, not indeed centrally, but far out at sea, and on the brightest part of the long bisecting streak. B. and M. make the depth of its interior 4000 feet below the W. wall, and the height of its E. wall 1600 feet from the plain. Schr. gives a depth of about 3400 feet, but observes that in such minute measures an error of $\frac{1}{3}$ might easily occur; the height of the E. wall he states at 900 feet, with two peaks of 1000 feet, casting a cone of shade at each extremity. I think I have remarked a singular form in the

outline of its shadow. Of smaller craters there are a good many, and Schr. has delineated some not to be found in B. and M. or Lohrm., reckoning up on one occasion twenty-two, though the plain was not fully illuminated. This might in part be due to the superior light and power of his 13-ft. reflector, which had an aperture of 9½ inches;* but it needs no great amount of selenographical experience to be aware how little stress can be laid upon such discrepancies. Yet we must not pass over everything of this kind too inconsiderately, or allow ourselves to form a habit of invariably refusing a less plausible explanation of unknown phænomena. With this error Schr. was certainly noways chargeable; on the contrary, we find him constantly deducing conclusions from premises which others might consider inadequate. Thus, on the occasion referred to, he lays much stress upon the circumstance that instead of two whitish heights and a hollow, with a speck like a minute hill in its centre, which he had formerly noted towards the middle of the plain, with his 7-ft. reflector made by Sir W. Herschel, and which he had never subsequently seen with any instrument, or under any angle of illumination, during upwards of seven years, he now found two distinct bright small craters: while at the same time he perceived two other small craters, hitherto unknown, in a place where he ought to have noticed them in two observations nearly five years before: he found the place of a little crater, recorded more than seven years before, occupied by a grey spot like a longish low hill; and in another region could not identify some well-known ridges amidst an aspect of general confusion. From all this he inferred of certainty of some variation in the lunar atmosphere, induced by natural or possibly even artificial causes, connected with the agency of living creatures. We may perhaps be disinclined to follow his line of argument to its full extent. We may think that he did not always sufficiently bear in mind the spirit of his own important remark, that "the longer and more frequently one and the same small spot is observed, so much the more we discover." We may consider it desirable to wait for a fuller and a more rigidly convassed collection of facts before we attempt to make them the basis of a generalization. But we should not therefore be acting discreetly in rejecting any result of careful observation, however contrary it may seem to our preconceived opinions; and the history of science may teach us, that of the two extremes, the visionary is more likely than the sceptic to push forward the boundaries of knowledge.

Many of the ridges which intersect the plain, and which Schr. compares to the veins of animal or vegetable substances,

* Probably of the Calenberg scale, equal to a little more than nine English inches.

are very low; but close to the terminator, where the sun is only 1° or 2° high, he found that they cast measurable shadows, especially from their more rapid slopes. The faintness, however, of the terminator rendered it difficult to make them out well; even a keen eye requires practice to distinguish them; and years elapsed before he was able to measure the length of the shadow, and the distance of the ridge, with complete certainty. The effect of "penumbra"* is sensibly felt here, and should be adverted to by the student. It is evident that the true terminator, or circle, dividing the lunar globe into two equal hemispheres, must be found where the centre of the sun is in the lunar horizon. But the upper hemisphere of the sun casts a considerable amount of light beyond that line, gradually decreasing till the whole solar globe is invisible, but, owing to the variety or absence of a lunar atmosphere, retaining a perceptible illuminating power to the last; and hence the true terminator is carried forward beyond the hemisphere by a "penumbra," or border of about 8″, of continually increasing duskiness, which may be traced on level ground by an experienced eye. A similar effect may sometimes be noticed in softening the brightness of mountain tops at a distance beyond the terminator, and the existence of this penumbra is occasionally apparent in other situations, and under higher angles of illumination. Most of the shadow on the moon is indeed black midnight, from the absence of atmospheric diffusion; but a practised eye will occasionally detect an incomplete illumination, derived from the partial visibility of the solar globe. In some instances no doubt a grey tint, as seen from the distance of the earth, may result from the presence of innumerable and undistinguishable specks of black shadow thickly scattered over a roughened surface; but in other cases we are able to trace the half-shadow, or rather half-light, resulting from the effect of a rising or setting sun; and Schr. thought he could perceive a want of sharpness at the points of long outstretched shadows arising from this cause.

The ridges of the *M. Serenitatis*, as the illumination increases, are converted into white streaks, and the other irregularities of surface become luminous, so that on one occasion, when he speaks of the magnificence of the scene, he could

* This term, in its strict optical meaning, would signify the whole space illuminated by anything less than the entire disc of the sun, instead of, as here, the portion enlightened by his upper visible hemisphere, in advance of the true terminator. The *whole* optical penumbra on the moon subtends about 16″ at the distance of the earth, but of course only its darker portion is perceptible, for the same reason that in solar eclipses the diminution of light is not sensible till a great part of the disc is obscured; and the extent of this visible portion will no doubt vary according to the power of the telescope and the sensitiveness of the eye.

count about thirty spots of light in the grey level, and at another time, by the aid of his great 27-ft. reflector, he was able to distinguish fifty-nine or sixty of various magnitudes, and probably might have detected still more. Such variations of aspect he was disposed to refer to modifications in the lunar atmosphere, and he considered them as forming a striking analogy to the occasional freckled aspect of the *M. Crisium*, mentioned in its place (INT. OBS. v. 203), the reality of which has been confirmed by modern observations, without the slightest clue being obtained to any more probable explanation.

DOUBLE STARS.

We shall revert to the diagram given in our last number for the purpose of identifying some objects contained within its area, and as yet undescribed. One is

150. 307 P. XIX. *Aquilæ*. 15″. 307°·8. 7 and 13. Lucid white and blue (1834·63). This is chiefly inserted as a test for light, in which respect it will be found convenient for moderate-sized telescopes. To me it is very easy. A seems to be pale orange (1865·65) There is a minute closer pair *p*, a little *s*, in the field. It will be found just following *o*, a 5-mag. star, about $1\frac{1}{2}°$ *n* of *Al Tair*.

151. Double star in *Sagitta*. Between γ and θ of this asterism we shall find η, a 6-mag. yellow star. At some little distance, perhaps 35′ or 36′, from this, *sf*, but more *f* than *s*, lies a pretty little open white 8-mag. pair, not mentioned by Admiral Smyth* or Σ (for whom it was probably too wide). When viewed in a large field, its aspect seems to bespeak physical connection. It is closely associated with a 12-mag. star, forming with it a right-angled triangle. Another less interesting double star occurs nearer η, *sp*, but more *s* than *p*.

The whole area comprised in our diagram is of such richness as well to repay the trouble of sweeping over with a low magnifier. A beautiful region may be pointed out, before we leave it, marked by two small stars (6 mag.) in the engraving between 6 and 8 *Anseris*, and 2 and 3 *Sagittæ*, but nearer to the latter. It is visible as a group to the naked eye, and is a fine object of a rudely triangular form in the finder, but is too wide for the telescope. The *f* star of the two southernmost

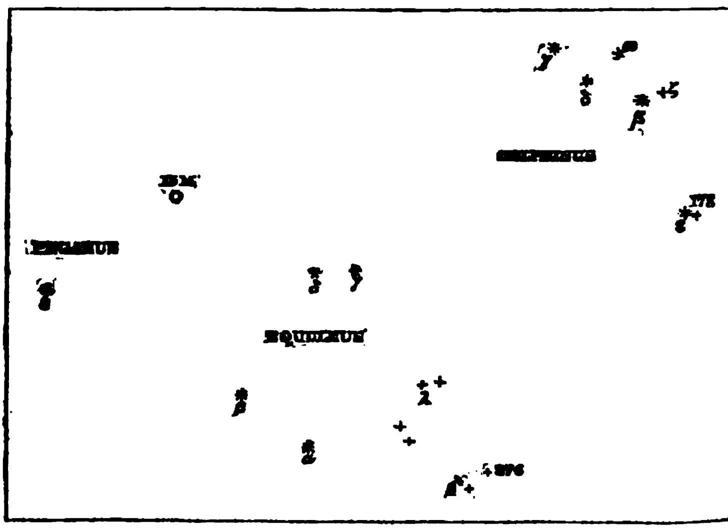
* On the first recurrence of the name of this illustrious astronomer, hydrographer, and antiquarian, after his departure from among us, it may be permitted to me to give expression to the regret which all scientific readers of these pages must feel, at the loss of one so distinguished alike by the variety of his attainments and his eminence in each of them.

"Nihil quod tetigit non ornavit."

Personally, I might add more; this very brief and imperfect tribute is due from all who love the objects of his most successful study.

among the brighter components, which is 5 *Anseris* (its companion being 4), is of a fine orange hue, verging to scarlet; it has a minute 12-mag. attendant *f*, a little *n*, and a brighter and more distant one *n* a little *p*. This great group is preceded by a minute triangle, 8½ and 9 mags., with a 10-mag. star in its interior.

We have at present no further reference to make to our previous diagram, but we shall now introduce another to aid us in the examination of an adjacent and not dissimilar region, which, though not illuminated by any very conspicuous star, is possessed of considerable interest. Like the preceding one, from its contiguity to the Galaxy, it is so rich in the smaller classes of stars that merely sweeping over it with an ordinary



finder will give us some little idea of the astonishing magnificence and variety of the heavens, while the further we are enabled to penetrate it the more we shall be impressed with the incomprehensible greatness of the Creator. We begin with the constellation *Delphinus*. Here a very striking pair, one of the most beautiful of its kind in our skies, γ, has already appeared as No. 63 of our list (Vol. II. p. 373), but it may be again adverted to, on account of the discrepancy between Sm.'s magnitude of B, = 7, and that assigned by Σ, who makes it 5, it being borne in mind that their constant difference would not be apparent in this part of their respective scales. To my own eye, Sm.'s rating certainly appears very

small. I should have thought it not lower than 6. It will serve also as a pointer to the following:—

152. Σ 2725. In the same field, if the power is low, with γ *Delphini*, lying *s*, a little *p*, we find a very pretty little pair, not mentioned by Sm., but designated as above, and described as 4″·237. 358°·05. 7·3 and 8 of Σ's, or about 8 and 8½ of Sm.'s scale. White and ash-coloured. The Russian astronomer thought a slow motion in angle probable.

The other bright stars offer nothing very remarkable, but between β and ζ, both yellow, the former the deeper, we should look for a remarkable little triangle of 8-mag. stars, whose very aspect seems to bespeak their mutual connection. It would be a curious though troublesome task to ascertain from the calculus of probabilities, how many chances there are against a mere perspective equality of brightness in three objects within so small a compass. If we are studying colours, we may sweep for two stars, one about 1¾° *n* of γ, a little *p*, 7 mag., pale red; another 1¾° *p* the last, a very few minutes *n*, fine orange.

We next find readily, by means of ε, which it closely precedes—

153. 178 P. XX. *Delphini* (marked simply 178 in diagram). 14″·3. 256°·1. 7½ and 8. Both white. To these, Sm. adds a 16-mag. companion, 20″, 125°, visible only by evanescent glimpses under clock-work with his 5$\frac{9}{10}$ inch object-glass; and Dawes a 9-mag., discovered by him as an elongation of 8, 1840·82, and confirmed by Sm., 1842·58, when he estimated the distance at 0″·7. As it had been unperceived by Σ in four measurements, our great astronomer was disposed to assume the binary character of the pair. I have found it a very difficult object with 5½ inches, but I think it appears elongated; at least it does not look exactly like its companion.

We proceed now to the little asterism *Equuleus*, an unaccountably shaped figure, said to be due to Hipparchus. What may have induced the venerable astronomer to insert the head and neck only of an animal is now past inquiry. There is no brilliant star here, *a*, the *lucida*, attaining only 4 mag. Three pairs, however, will well reward our search. We begin with the easiest to find, which is visible on any clear night to the naked eye as a minute but solitary and easily recognized star.

154. ε *Equulei*. 11″·2. 78°·1. 5½ and 7½. Pale yellow and bluish lilac. The pair is pretty, but it is converted into a most interesting group by the "duplicity" of A, discovered by Σ as an object of extreme difficulty, his measures giving 0″·35 and 294°·04 (1835·67). Only three years after, Sm. found it more open, 0″·5 and 290° (1838·83). Secchi's mean is 0″·819, 287°·44 (1855·876). Knott at the present time

(1865·68) finds 1″·075, 288°·08, establishing the binary character ascribed to it by Sm. His measures also of A C (or the wide pair) tend to confirm Secchi's opinion that there is angular motion in that quarter also, and in the same direction. Should this indeed be proved hereafter to be a mutually connected system of three revolving suns, what a wonderful instance it will exhibit of an arrangement so wholly unlike our own, and so superior in magnificence, if not comparatively diminutive in size; yet governed, as far as we can ascertain, by the same unchanging law. In their present position A and B form an exquisite pair. Secchi (who ascribes to them, by the way, a yellow and bluish tint) calls them "the most beautiful of beautiful objects." They answer admirably as a test for moderate-sized achromatics, with the convenience, for observers unprovided with circles, of being immediately identified by the presence of C. I can just separate them with a power of 170, and there is a black division with 212.

ε Equulei will be noted as one of three stars in the finder—those represented (but of course in a reversed position) in the diagram. The central one, which is also the smallest, offers nothing noticeable except its orange hue; but the further one lying *np* from *ε* must be examined more closely. It is—

155. 376 P. XX. *Equulei.* 1″·8. 286°·8. 6 and 8. Orange and purple. I fancied B pale tawny, 1865·73: but this is probably an instance of the singular uncertainty attending these colours, at least to some eyes, which I have mentioned elsewhere. Knott sees it lilac. Sm. calls this "an exquisite pair." The very accordant measures of Σ, Secchi, and Knott at distant epochs, give about 2″·13 as the distance, which must have accidentally been undermeasured by Sm. It is Σ 2375.

156. λ *Equulei* (*alias* 2, *i. e.* of Flamsteed's notation). 2″·6. 225°·6. 6 and 6½. Both white. This "lovely object," which is stationary, will be found with little difficulty from the diagram. It is somewhat remarkable that the affixer of the Greek letter, whoever he may have been (not, as usual, Bayer, who stops at δ), and Flamsteed should both have noted this star in preference to the brighter one which lies at a few minutes' distance *np*. If there is no suspicion of error here, it might lead to the idea of variable light in the latter star, which has been inserted in the diagram. λ is Σ 2742.

157. δ *Equulei.* 28″·2. 36°·8 (1838·59). 4½ and 11. Topaz and pale sapphire. This object is inserted in consequence of Mr. Knott's observation, that it is interesting from the remarkable change in position and distance, owing to the proper motion of the larger star. His data are 34″·488. 27°·67 (1865·718).

Before leaving this neighbourhood, it may be well to remind any of our readers who may not be acquainted with that eminently beautiful cluster, 15 M, that it lies at only a short distance, and may be readily found by means of δ *Equulei* and ε *Pegasi*, as will appear by the diagram. It has been described as No. 22 of our list, Vol. vi. p. 118.

OCCULTATIONS.

Nov. 4th, δ^3 Tauri, 6-mag., 9h. 58m. to 10h. 37m. 5th, 115 Tauri, 5½-mag., 10h. 8m. to 11h. 8m. 28th, B. A. C. 221, 6-mag., 6h. 11m. to 7h. 16m.

THE SPECTROSCOPE AND THE MICROSCOPE.

Mr. Browning has just completed the construction of an entirely new spectroscope, admirably adapted to microscopic investigations. Several of these instruments were exhibited at the Microscopical Society, on the 11th of October, and explanatory remarks were made upon them by Mr. Slack, to whose microscope one had been adapted, and which he represented as working admirably and with great facility.

Some time ago Mr. Sorby applied a spectroscope to the microscope, using the latter instrument as a telescope, by which the spectra afforded by a transparent object could be viewed. Great credit was due to Mr. Sorby for thus indicating a variation in the method of spectroscope inquiry, and some of his results were very interesting; but it occurred to several scientific men that it would be better to apply the spectroscope to the microscope than the microscope to the spectroscope, and the first important step in this direction was taken by Mr. Huggins, who made a communication on the subject to the Microscopical Society on the 10th of May, 1865. In Mr. Huggins' plan an adjustible slit was placed three or four inches behind the object glass, "behind the slit at its own focal distance is placed an achromatic lens," which transmitted parallel rays to an angular-shaped spectroscope similar to the ordinary kind. Mr. Huggins pointed out in the paper to which we have referred, that "the spectrum of any part of a microscopic object could be examined apart, and also can be compared with the spectra of adjacent portions of the object. In this manner the spectrum of a single blood disk, or the spectrum of the contents of a single cell, can be observed, and any changes in living tissues which cause a modification of the spectrum can be watched and investigated." In the

same paper the application of the instrument to opaque objects was also pointed out, and Mr. Wenham, who stated that he had assisted Mr. Huggins in some of his investigations, said, "We so far differ from Mr. Sorby that we are able to make an analysis of the smallest microscopic object, such as the smallest portion of a blood disk, mounted in the ordinary way. We can get a strong spectrum, and the power of the object-glass gives a better result. . . . . We found some curious results from investigating opaque objects. In all spectrum analysis the difficulty is to get a monochromatic light. Generally we get a spectrum of some sort; but from the surface of many opaque objects the reflected light is perfectly monochromatic."

At the meeting of the Society, at which the preceding remarks were made, Mr. Slack stated that he had tried a direct vision spectroscope made by Mr. Browning for Mr. Gassiot, and that an instrument of this description would be convenient for use with the microscope. Mr. Browning had already turned his attention to this matter, and after many experiments, in some of which we believe Mr. Sorby took part, he devised a compound prism, giving direct vision, and having an amount of dispersion very well adapted for the exhibition of delicate absorption bands.

The new spectroscope for the microscope may be used under the stage, when required; but its most convenient place is that of an ordinary eye-piece. As will be seen from the figure subjoined, it is a very compact piece of apparatus, very ingenious in construction, and consisting of several parts. The prism is contained in a small tube, which can be removed at pleasure. Below the prism is an achromatic eye-piece, having an adjustible slit between the two lenses; the upper lens being furnished with a screw motion to focus the slit. A side slit capable of adjustment admits, when required, a second beam of light from any object whose spectrum it is desired to compare with that of the object placed on the stage of the microscope. This second beam of light strikes against a very small prism suitably placed inside the apparatus, and is reflected up through the compound prism, forming a spectrum in the same field with that obtained from the object on the stage.

Mr. Wenham pointed out the importance of so far modifying Mr. Huggins's plan as to allow any small object to be brought into the field and focussed in a convenient way. In Mr. Browning's plan nothing is easier. The prism is taken off and the slit opened by turning a screw. The apparatus then acts simply as an eye-piece, and a single blood disk may be brought exactly in the middle of the field. The spectroscope slit may then be closed so as to isolate the blood disk from

similar disks on either side of it, and then a small shutter, worked by another screw, diminishes the length of the slit to any extent required, and the blood disk, or other minute object, is seen in a little optical cage, which shuts out the view of other bodies. The prism is then replaced, and if all the adjustments are in order, the absorption bands produced by blood are distinctly seen. We have found it easy to operate in this way with an object-glass as high as Smith and Beck's $\frac{1}{20}$th.

Very important results may arise from Messrs. Huggins's and Wenham's micro-spectroscopy of opaque objects. With a two-thirds or half-inch objective it is easy to get a good spectrum from a portion of blood dried on a card or a bit of glass, and not bigger than a full stop in small print. A similar portion of dried blood may be viewed conveniently with higher powers as a transparent object.

We reserve for another occasion a description of some interesting experiments which will illustrate the kind of inquiry for which the application of the spectroscope to the microscope is adapted. Solutions and fluids of various kinds may be placed in small cells, or, as Mr. Slack pointed out at the Microscopical Society, minute drops of various substances may be placed upon a glass stage and their spectra examined before and after reagents are applied. The small drops required can, as he explained, be handily taken up by glass rods drawn out to the thickness of a needle, and having a little crook at the end. The glass stage should have the bottom ridge turned in at an acute angle, and glass sides, by which means the fluids are prevented from escaping on the stage. Unless very small drops are placed on this glass stage they run down too easily and spoil the experiment.

Mr. Browning deserves great credit for the skill displayed, both in the invention and construction of this new and very elegant spectroscope, which is exceedingly easy to use, though a little complicated to describe.

We append a view of this spectroscope, with a description of the parts, so that our readers will find no difficulty in applying it to their microscopes.

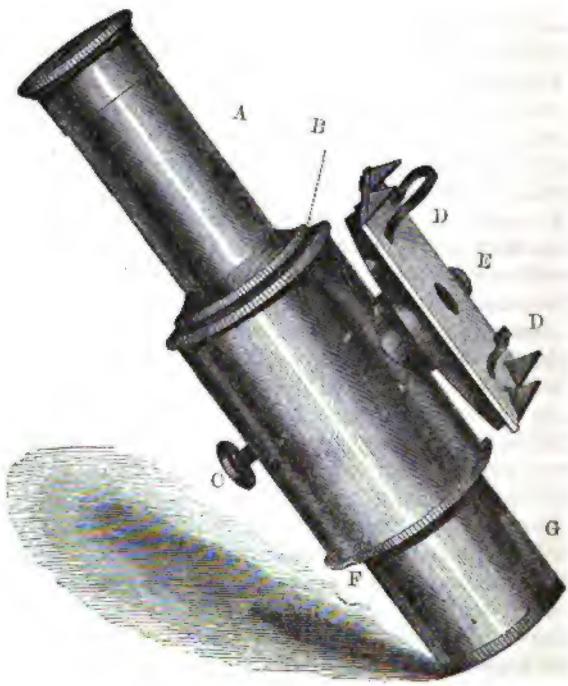
A is a brass tube carrying the compound direct vision prism.

B, a milled head, with screw motion to adjust the focus of the achromatic eye lens.

C, milled head with screw motion to open or shut the slit *vertically*. Another screw at right angles to C, and which from its position could not be shown in the cut, regulates the slit horizontally. This screw has a larger head, and when once recognised cannot be mistaken for the other.

D D, an apparatus for holding small tube, that the spectrum given by its contents may be compared with that from any other object on the stage.

E, square-headed screw, opening and shutting a slit to admit the quantity of light required to form the second spectrum. Light entering the round hole near E, strikes against the right-angled prism which we have mentioned as being placed inside the apparatus, and is reflected up through the slit belonging to the compound prism. If any incandescent object is placed in a suitable position with reference to the round hole, its spectrum will be obtained, and will be seen on looking through it.



F shows the position of the field lens of the eye-piece.

G is a tube made to fit the microscope to which the instrument is applied. To use this instrument insert G, like an eye-piece, in the microscope tube, taking care that the slit at the top of the eye-piece is in the same direction as the slit below the prism. Screw on to the microscope the object-glass required, and place the object whose spectrum is to be viewed on the stage. Illuminate with stage mirror if transparent, with mirror and lieberkuhn and dark well if opaque, or by side

reflector, bull's-eye, etc. Remove A, and open the slit by means of the milled head, not shown in cut, but which is at right angles to D D. When the slit is sufficiently open the rest of the apparatus acts like an ordinary eye-piece, and any object can be focussed in the usual way. Having focussed the object, replace A, and gradually close the slit till a good spectrum is obtained. The spectrum will be much improved by throwing the object a little out of focus.

Every part of the spectrum differs a little from adjacent parts in refrangibility, and delicate bands or lines can only be brought out by accurately focussing their own part of the spectrum. This can be done by the milled head B. Disappointment will occur in any attempt at delicate investigation if this direction is not *carefully attended to.*

This spectroscope can be fitted so as to go under the stage of any microscope, but it is probable that it will be little used in this position, as for nearly all experiments the mode described is more convenient. When the spectra of very small objects are to be viewed, powers of from $\frac{1}{2}$ inch to $\frac{1}{20}$th, or higher, may be employed.

Blood, madder, aniline red, permanganate of potash solution (quite fresh) are convenient substances to begin experiments with. Solutions that are too strong are apt to give dark clouds instead of delicate absorption bands.

Mr. Browning makes small cells and other contrivances to hold fluids for examination.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from Page* 226.)

1518. During the nights preceding April 6, a pale comet was seen above the citadel of Cremona.—(Cavitellius, *Annales Cremonenses.*)

1520. In February, a comet appeared.—(Biot.)

1521. In April, a comet with a short tail appeared in the latter part of Cancer.—(Vicomercatus, Lubienitzki.)

1522. A comet was seen in the W.—(Mizaldi, ii. 11.) No month given.

1523. In July, a comet was seen near *α* Ophiuchi.—(Biot.)

1529. In February a long star traversed the sky. This phenomenon renewed itself in August.—(Biot.) European

writers mention a comet in August, but Pingré considered that their description applied rather to an aurora.

1530. On November 30, a comet was seen.—(Conradus Urspergensis, *Chronicon.*)

1532. A comet appeared in the spring.—(Gaubil.) On March 9, a star with a tail appeared in the S.E.; after nineteen days it disappeared.—(Biot.)

1534. A comet appeared in July.—(Cavitellius *Annales Cremonenses.*) On June 12, a star was seen near π Cygni, κ Andromedæ, etc.; it passed θ Andromedæ, and entering ν, ξ, υ, π Cassiopeiæ, disappeared after twenty-four days.—(Biot.)

1536. On March 24, a star was seen near β, γ Draconis; it went eastwards, and passing to the W. of δ, ϵ, π, ζ Draconis, came to the Milky Way, and disappeared on April 27.—(Biot.)

1538. On January 17, P. Apian saw a comet with a tail 30° long, in 5° of Pisces, with a latitude N. of 17°. On the 22nd, Gemma Frisius observed it in 9° of Pisces, with a latitude N. of 11°.—(Pingré, *Comèt*, i. 499.)

1539. On April 30, a comet with a tail 3° long was seen. It remained visible for three weeks, and swept α and γ Leonis.—(Biot, etc.) On May 11 (?), Gemma Frisius observed it in 5° of Leo, with a latitude N. of 12°. On May 17, at ten hours in the evening, its position, according to Apian's observation, reduced by Pingré, was 20° of Leo with a latitude S. of 4½°.—(Pingré, i. 500.)

1545. A comet was seen for several days this year. No month is named.—(Aretius, *Brevis Comet. Explicat.*)

1554. On June 23, a comet was seen, which passed from δ to θ Ursæ Majoris. It lasted four weeks.—(Biot.)

1557. In October, the sun being in Libra, a comet was seen in the W. in Sagittarius.—(Camerarius, *Cometæ.*) On October 22, a comet was seen near λ of Limchi. It lasted till the next moon.—(Biot.)

1560. In December, a comet appeared for a month.—(Thuanus, *Historiæ*, xxvii. 11.)

1569. On November 2, a comet was seen in Ophiuchus, and in the signs Sagittarius and Capricornus. Its movement in longitude equalled the extent of these two signs, and it remained visible till November 19.—(Kepler, *de Cometis.*) It lasted from November 2 to November 28.—(Biot)

1578. On February 22, a star as large as the sun appeared. —(Biot.) European writers mention a comet and a hairy star. The latter on April 1, as Tycho Brahe's comet of 1577, remained visible till January 1578. Pingré thinks that this is the object described as the comet of 1578; the hairy star of April he considers to have been a meteor.

1584. On July 1, a star appeared in the division of π Scorpii.—(Biot.)

1591. On April 3, a comet 1° long was seen. It traversed Pegasus and Aries, increasing in length to 2°. On April 13 it entered the division of β Arietis.—(Biot.)

1604. On September 30, a large star, like a ball, appeared in the division of μ^2 Scorpii. It vanished in the S.W. in November. On January 14, 1605, it reappeared in the S.E. About March it became dim.—(Biot.)

1609. A great star appeared in the S.W.—(Biot.)

1618. [ii.] Between November 10 and 26, a comet was seen by Figueroes, at Ispahan, coincidently with the apparition of Comet III. of this year. In consequence of the comet's southerly position, the head was not generally (if at all) seen in Europe; only the tail. Kepler and Blancanus were the chief observers who saw the latter. Kepler *guessed* that on November 10 the nucleus was in 16° of Scorpio, with a latitude S. of 8°, and that on November 20 it was near the head of the Centaur. At Rome the tail was seen to be 40° long on November 18. It was last observed there on the 29th. The observers (Jesuits) note that in eleven days, the proper motion of the tail caused it to pass over 24° from Crater towards α Hydræ.—(Pingré, ii. 5.) It may be well to mention here that Mr. Cooper, in his valuable *Cometic Orbits*, p. 77, appears to have fallen into a mistake relative to the comets of this year, which others have copied. He gives the elements of the third comet, and appends notes referring to the second and third, as if they were one and the same object.

1619. In February (?) a comet was seen in the S.E.; it was long.—(Biot.)

1625. From January 26 unto February, a comet was observed by Schickhardt in Hidamus and Cetus.—(*Astronomische Nachrichten*, No. 31, April 1823.)

1639. On October 27, a comet with a small tail was seen in Caius Major, by Placidus De Titis.—(*Ast. Nach.*, No. 171, January, 1830.)

1640. On December 12, a comet was seen.—(Biot.)

1647. On September 29, a comet was seen soon after sunset, in Coma Berenicis. Its longitude was 188°, and its latitude + 26°. It was 12° long, and lasted one week, traversing Boötis N. of Arcturus, to Corona Borealis, in a line sensibly parallel to the equator.—(Hevelius, *Cometographia*, p. 463.)

1699. [ii.] On October 26, Godefroi Kirch observed a faint comet in the poop of Argo, in longitude 122° 34′ and latitude − 40° 38′. It was visible to the naked eye, and its motion was sensibly southwards. Kirch was unable to find it on any subsequent night.—(*Miscell. Berlin*, v. 50.)

PROGRESS OF INVENTION.

PHOTO-PRINTING.—Attempts have been made in various ways to multiply copies of photographs by means of the press; but hitherto the mode in which the various shades are produced by photography have been an insuperable obstacle to complete success. The difficulty, it is probable, has now been overcome, and simultaneously by two persons, by very simple means—the combined use of the principle of carbon printing, and of an ink which, unlike that ordinarily employed, produces a depth of shade dependent on quantity. A glass plate, after having been coated with a mixture of gelatine and sugar, and sensitized with bi-chromate of ammonia, is exposed in the usual way under a negative; after which the gelatine, which has not been rendered insoluble by the action of light, is washed away. A positive picture in relief is thus produced; and a copy of this, in a substance suited to the purpose, is obtained for use in printing. This copy may be made by means of the electrotype process, or by placing a sheet of soft metal over the picture in gelatine, laying both between slabs of cast iron, and subjecting to pressure; or simply by pouring melted sulphur on the gelatine. The electrotype copy is troublesome on account of the mounting required; but as the indentations are deeper it gives better impressions than the plate of soft metal. The copy in sulphur will answer very well in some cases.

To take impressions, ink is made by soaking gelatine in water, then melting it and mixing with it carbon, or even a colouring matter, in very fine powder. If colouring matters are used, they must not be such as are acted upon by the bi-chromate. To take an impression a small quantity of the ink, kept in the fluid state by heat, is poured on the centre of the electrotype, or other copy; a sheet of photographic paper is placed on this, and over the paper a plate of glass; after which, a pressure is applied, that forces the ink into all the hollows, leaving little or none elsewhere. When the ink is cold, it adheres only to the paper, along with which it is entirely removed from the electrotype, especially if, after several impressions have been taken, the plate is slightly greased. All the effects of light and shade are produced by the varying thickness of the ink which has been thus transferred to the paper.

NEW MODE OF FILTERING WATER.—Capillary attraction has been adapted by M. Aman Vigié, to the filtration of water; and as the principle seems easily applicable on the large scale, the method he uses will, most probably, be very generally adopted. While, looking to the sources whence we are obliged to obtain water for domestic purposes, the necessity of filtrating it is universally admitted, the mode of effecting this thoroughly and rapidly is attended with considerable difficulty, on account of the stopping up of the pores of the filter. M. Vigié having observed that when a fluid is raised by means of capillary attraction, the particles of solid matter floating in it do not rise along with it, it occurred to him that this fact, in conjunction with the principle of the syphon, might be applied, even

on the large scale, to the filtration of water—the *modus operandi* being exemplified by the emptying of a bason of water, which most persons have, to their surprise, observed to occur, when a towel hangs down from a bason, etc., of water, in which one corner of it has been accidentally immersed. Capillary attraction in the towel, and the principle of the syphon formed by it, causes the water to be very soon carried over the edge of the bason and poured on the floor. M. Vigié uses, instead of the towel, a porous earthenware, which not being acted on by moisture, is very durable. When the shorter end of the syphon formed of it is placed even in mud, pure water ascends continuously, and the pores remain without being stopped up.

Simple Mode of obtaining Zirconium.—This elementary substance, which has hitherto been procurable only in small quantities, may now be had to any amount, with but little trouble and at a moderate cost, by the method devised by Dr. Phipson. Having discovered that the silicic and boracic acids readily give up their silicon and boron when fused with magnesium, he suspected that zircon might be obtained in the same way, and found on trial that such is the case. The reduction occurs when the magnesium fuses: and, on dissolving out the magnesia which has been formed with hydrochloric acid, zirconium in the form of a velvet black powder is obtained. Titanium may be procured in the same way; but it is worthy of remark that while, during this process, gases are formed with silicium and titanium by combination with hydrogen, such is never the case with boron or zirconium.

Applications of Superphosphate of Lime in the Manufacture of Sugar.—Great loss is experienced in the manufacture of sugar by the change of cane sugar into grape sugar, which is very inferior in sweetening power, is highly hygrometric, and besides is attended by other inconveniences. As, however, its formation depends on the temperature at which the saccharine juice is evaporated, and the time occupied by the evaporation, great saving has been already effected by an attention to these circumstances, and an application of correctives suggested by science. Much, however, still remains to be done, and the loss experienced in the manufacture of maple and sorghum sugars is very great; nor has it been entirely eliminated in the production of cane and beet-root sugars. But it has been found that the waste may be reduced to a *minimum* by the addition of superphosphate of lime to the juice before boiling it.

Economic Production of Methylic Ether.—This ether, which is obtained from methylic alcohol, or wood spirit, has hitherto been obtained by means neither convenient nor safe. M. Tellier, to whose ice machine we have already directed the attention of our readers (No. xlv., p. 230), and who uses it instead of amylic alcohol, has discovered a very simple method of producing it in any required quantity. He forms it by mixing nearly equal quantities of sulphuric acid and methylic alcohol, and causes it to be evolved in the state of vapour by heating to about 120° C., at which temperature—a constant current of wood alcohol being made to flow into the mixture—an uninterrupted emission of gaseous methylic ether

takes place. He uses chiefly two modes of condensing the vapour; in one it is transmitted into alcohol, with which it immediately combines, and it is set free as an oily looking liquid, which floats on the surface by the addition of water, glycerine, or anything else for which the alcohol has a stronger affinity than for the ether. The supernatant methylic ether is obtained separate by drawing off the dilute alcohol, which may be rectified for subsequent use; and it is to be thoroughly dried by the application of fused chloride of calcium, or some other substance having a strong affinity for water. By the second method the ethereal vapour is transmitted into sulphuric acid, which also, if the temperature is kept tolerably low, rapidly dissolves it, forming a solution of methylic ether in sulpho-methylic acid. Heating this to 120° C., ethereal vapour will pass off, but not at a sufficient pressure to produce condensation. To effect this, which, under the circumstances, requires a pressure of about five atmospheres, the vapour given off by the first solution is transmitted into similarly saturated sulpho-methylic acid, which produces a supersaturated solution; and when this is distilled, the resulting vapour, which is large in quantity on account of the richness of the solution, is condensed in vessels strong enough to bear the required pressure,

Decomposition of Sulphurous Acid Gas.—Large quantities of sulphurous acid gas are evolved in certain manufacturing processes: and the escape of these into the atmosphere is not only a waste of valuable materials, but a source of mischief to vegetation, and even to health in the surrounding districts. Many means of preventing, or at least mitigating, this evil have been used; one of the best has been discovered recently, and is founded on the fact that sulphurous acid is decomposed by sulphuretted hydrogen. To decompose the sulphurous acid on the large scale, it is conducted, thoroughly mingled with sulphuretted hydrogen, into a suitable chamber, where the sulphur, in a state of minute division, and fit for many purposes, is deposited; the results of decomposition being sulphur and watery vapour. The sulphuretted hydrogen is obtained by acting on sulphuret of barium with dilute hydrochloric acid; and the chloride of barium which is formed being decomposed with sulphuric acid, the hydrochloric acid is set at liberty, and may be again used for decomposition of sulphuret of barium.

Simple Mode of Obtaining Chlorine.—The ordinary methods of obtaining chlorine by decomposition of hydrochloric acid are attended with certain inconveniences, from which that invented by M. Parmentier is entirely free. He decomposes the acid by dropping into it small quantities of pulverized chlorate of potash, which immediately causes the copious evolution of chlorine, the only residuum being water. This method possesses peculiar advantages when the chlorine is required for the purpose of disinfection; since it may thus be obtained with great rapidity and ease, and its further evolution may at once be prevented, when enough has been evolved, by the interruption of the supply of chlorate of potash, and still more rapidly by the addition of water to the acid.

Substitute for the Steam-hammer.—Nothing has contributed

more to our powers of manufacturing iron and steel, on the large scale, than the invention of the steam-hammer. Without it, in reality, our other improvements in metallurgy would have been deprived of nearly all their value; since the great necessity at the present day in engineering is the forging of enormous masses in a sound and reliable manner, which would be impossible even with the best forms of the old tilt hammer. The steam-hammer has been brought to an extraordinary degree of perfection, but is likely in many instances to be superseded by the still more simple application of the elasticity of the air as a substitute for steam. The atmospheric, like the usual form of steam-hammer, has the mass with which the blow is struck attached to the lower end of a rod, which is fixed to a piston that moves up and down within a cylinder. But instead of this piston being raised and depressed by the introduction of steam below and above it, the cylinder itself is alternately made to ascend and descend, by being connected with a revolving crank. When the cylinder is raised, the air which has been admitted beneath the piston is compressed until its elasticity is sufficient to lift the piston and the hammer attached to it. When the cylinder is depressed, the air above the piston is compressed, and, by its elastic power drives down the piston and hammer with great force and velocity. The piston is prevented from falling, before the elasticity of the air above has begun to act upon it, by the rapidity with which the compressions above and below succeed each other.

PRODUCTION OF NITRIDE OF IRON.—Nitride of iron, which has been ascertained to be the only compound of nitrogen and iron, and is an ammonium in which the whole of the hydrogen is replaced by iron, may be conveniently obtained by passing ammonia over pure protochloride of iron, at a temperature which is just sufficient to drive off in vapour the chloride of ammonium that is produced. The residue is nitride of iron in thin laminæ, or a grey powder. It is decomposed by a high temperature, as also by chlorine, acids, etc. If pulverized, which is easily done, and thrown into the flame of a spirit lamp, it burns with the production of brilliant scintillations. Heated in hydrogen, the nitrogen is driven off, and the softest and purest iron known is left behind.

A NEW AND POWERFUL LIGHT.—A brilliant light, which answers well for photography, is obtained by M. Carlevaris, by throwing on chloride of magnesium the flame obtained by means of a jet of coal gas, and a mixture of atmospheric air with one-tenth of its volume of oxygen. Fifty litres of coal gas, and about one hundred of atmospheric air, used in this way, per hour, were found to illuminate an immense apartment so thoroughly that it was possible to read with ease in every corner of it.

MISCELLANEOUS.—*The Sewage Plant.*—The nature and habits of this curious plant, which is such an obstacle to the filtration of sewage, have lately been investigated with considerable attention. It makes its appearance in the globular or filamentous form, according to circumstances, and is a species of fungus, of a drab colour, passing into black. Cool weather is more favourable to its produc-

tion than hot; and it varies in size from that of a grain of sand to several inches. It deodorizes the sewage by absorbing the offensive gases; but when broken emits a very disagreeable odour.——*A Harmless Green for Paperhangings*, etc.—The dangerous consequences attending the use in paperhangings of a green colour obtained by means of arsenic, are well known; an excellent substitute for this poisonous substance has been discovered in a compound consisting of three equivalents of barytes and two of manganic acid. It may be prepared by thoroughly mixing three or four parts moistened caustic barytes, two parts nitrate of barytes, and two parts oxide of manganese: fusing the mixture in a crucible heated to dull redness: pulverizing the residual mass, and washing the powder first with boiling and then with cold water, in an atmosphere free from carbonic acid. In this way is obtained a fine emerald green powder, which, under the microscope, is seen to consist of small transparent hexagonal crystals. It is applied to paper by means of thin glue, or the white of an egg.——*Zinnalin.*—This beautiful yellow dye is the final result of the action of nitric acid on aniline or any of the dyes obtained from it. Its reactions are precisely opposite to those of aniline, since it is reddened by alkalies, and changed again to yellow by acids. It may be obtained by adding nitric acid to aniline; a violent reaction takes place, the temperature rises considerably, and a dense yellow vapour, having a very disagreeable odour, is given off. Unless the temperature is kept within certain bounds, instead of the dye being formed, the aniline will be entirely decomposed. The residual liquor, which has a reddish yellow tinge, is to be evaporated in a water bath; and thus a red mass is obtained. When this is pulverized, it greatly resembles cinnabar (in German *zinnober*), and on this account, and from its having been derived from aniline, it has been called *zinnalin.* It imparts to wool or silk a beautiful reddish colour, which is not altered by light or air. It is soluble in alcohol, and still more readily in ether.——*New Method of Hardening Cast Iron.*—Having been raised to a low red heat, it is to be plunged into a liquid containing, for every gallon of water, about two and a quarter pounds of sulphuric acid, and two and a quarter ounces of nitric acid, and kept immersed until it is quite cold. Its surface will then be found, to the depth of more than the one-hundredth of an inch, as hard as tempered steel; and no distortion will have taken place, if it has been plunged as speedily and uniformly as possible into the fluid.——*Screw Float for Paddle Wheels.*—It is well known that a great vibration is produced when the floats of the ordinary paddle wheel enter and leave the water, and that they cause a large and useless expenditure of power, in giving motion to a very considerable body of water. Dr. Croft has invented a float which is in the form of a screw surface, and which, both by experiments with models, and by calculation, has been proved free from these objectionable properties. It remains, however, as yet to be shewn practically that it will take a sufficient hold of the water, and will economise power.——*Waywiser for Cabs, etc.*—Everywhere there

is more or less danger of a dispute between the driver of a hired vehicle and the person who uses it; this is true, even in Paris—though less, perhaps, than in most other places. A driver also may cheat his master, since there is generally but an imperfect check upon him. These inconveniences are likely soon to come to an end, as a very ingenious contrivance has been recently invented at Paris, and is now being tried there, which is expected to put it out of the power of the driver to impose upon either the traveller or his master. It records, in a way distinctly visible, the exact distance traversed, the time consumed in traversing it, the number of stoppages, and the length of each. Also, for the benefit of the master, the number of journeys made in the day, with the time and distance corresponding to them respectively. —— *Production of Magnesium.*—This metal will, very probably, soon become an indispensable requisite, not merely for photography, but for many ordinary purposes. All that is required for this is that its price should become moderate, which it is probable will soon be the case—it has already fallen more than fifty per cent. The cost of this metal, as an illuminating agent, is very easily calculated. A wire of it, the one-thousandth of an inch in diameter, affords a light equal to that of seventy-four Stearine candles of five to the pound. Three feet of this will be burned in a minute—that is, a quarter of an ounce in an hour, which, at the present reduced rate, would cost about two shillings and sixpence. A further reduction, consequent on increased demand and improved methods of production, may be anticipated; but it never can be very cheap as long as sodium is indispensable to obtaining it. There are many purposes to which it will be difficult ever to apply this light, on account of the large quantity of caustic magnesia which is given off as a very fine powder, and which soon renders the atmosphere intolerable. Proper methods of ventilation may, however, in a great degree, remedy this inconvenience. It does not exist in photography, the light is required for such a short time. The magnesium light is not to be considered a perfect substitute for that of the sun, being five hundred and twenty-five times less intense. Its actinic power is the one thirty-sixth of that of the sun.—— *The Capabilities of the Steam-Engine.*—Three Cornish engines have drained the Lake of Haarlem, which contained eight hundred million tons of water, a quantity which would supply London for seven years, and which covered 45,230 acres to an average depth of fourteen feet. These engines, when all the pumps are working, are capable of raising one hundred and nine tons of water ten feet at each stroke.——*Curious Fact in Acoustics.*—If the immense bell, which is in a large chamber at the base of one of the towers of Notre Dame in Paris, is struck with the closed hand, a large volume of sound will be produced, and will be audible to a considerable distance all round; but it has been discovered that it will be perfectly inaudible if the person advances within the bell to the centre, the sound diminishing as he proceeds from the circumference.——*Substitute for Tea, etc.*—It is curious that various portions of the human race have, without being conscious of it,

discovered the means of obtaining the same active principle from very different sources, as theine from tea, caffeine from coffee, etc. This principle undoubtedly produces very important effects on the system, though what precisely these are can only be conjectured. A new source of it has lately been discovered by Dr. John Attfield in the Kola-nut, which is used as an article of food by the natives of Western Central Africa. It is, however, not likely in any way to supersede tea or coffee in these countries. Its taste is not agreeable, and the quantity of theine it contains is very small compared with what is found in tea and coffee. The specimens examined were in the dry state, which may have modified the results.——*Manufacture of Sugar.*—By the ordinary mode of producing sugar from cane juice, a considerable amount of uncrystallizable sugar or fructose, in the shape of molasses, is produced: this may be considered as so much waste. The longer the process of boiling and the higher the temperature, the more fructose, the quantity being, in ordinary cases, so much as twenty per cent. It was found that cane juice, containing only twenty-six per cent., after an hours' boiling at 250 degrees in a closed vessel, contained fifty-five per cent. This production of uncrystallizable sugar may be avoided by rapid evaporation in an apparatus which has been termed a "concreter," and which consists of a series of very shallow vessels connected together, the evaporation being effected by hot air. The small quantity of fructose originally in the cane juice is not increased during the process, nor the amount of acid. The sugar thus obtained is perfectly dry and solid, and is ready, without further treatment, to be sent over to the refiner; it is said also to be free from that pest, the sugar beetle. The quantity of sugar gained in this way will cause an additional profit of £4 per hogshead. This will ultimately prove, it is hoped, a serious benefit to both producer and consumer.——*Flying Machines.*—The American Government, induced by some experiments made by the late General Mitchell, from which it was concluded that a twenty-foot screw fan revolving with a certain velocity, would lift much more than six tons into the air, has ordered the construction of an aeronautic machine on a large scale. It consists of a cigar-shaped copper canoe, strengthened with iron ribs, and having in the centre an engine capable of driving four screw fans having twenty-foot blades. One of these fans is placed above, and another below the canoe, to produce ascent or descent, and one at each end to effect a progressive or retrograde motion; and the whole, when complete, will weigh, it is expected, only about six tons.——*Wire Cannon.*—A cannon of very peculiar construction has recently been constructed, and the American Government has ordered experiments to be made with reference to it. In forming it, the core is of bronze, which is reduced by the boring to the thickness of only a quarter of an inch. Around this, steel wire is wound tightly to the depth of about an inch, the coils being in a diagonal direction, and those of one layer crossing those of the next at right angles; the whole is then raised to a high temperature and immersed in melted bronze. This mode of construction appears to afford great strength; 500 rounds were fired without the piece being in

the least affected—the charges consisting of one pound of powder, and the projectile weighing seven and three quarter pounds, the bore being two and a half inches. But some slight inconvenience was experienced from the recoil, on account of the lightness of the cannon, which weighs only 167 pounds.

ARCHÆOLOGIA.

During the past summer, and a part of the autumn, extensive researches have been made under the direction of the Rev. William Greenwell, of Durham, well known for his successful antiquarian labours, into the early barrows, or sepulchral mounds in the North of England. These researches have been attended with interesting results, but we can still only look upon these barrows as belonging to a very questionable date, which it will require more facts than are yet known to determine. This year, Mr. Greenwell's labours have been confined chiefly to the neighbourhood of Castle Howard and Malton, the latter place undoubtedly the representative of a Roman town. In general, the barrows opened by Mr. Greenwell present variations in the modes of interment, examples of which were already known in Yorkshire; but altogether they are of so much interest, that we hesitate in attempting any detailed account of them, until, as we trust, the discoverer will give us, as he alone is capable of doing well, his own description of them, with engravings of the objects found. The greater number of these interments were attended with cremation, and accompanied chiefly with urns of rude pottery, and a few wrought flints. The pottery, whether urns or cups, belongs to a type already well known, and in much of which the eye of an antiquary well experienced in Roman antiquities can hardly fail to recognise a rude imitation of Roman forms and ornaments. The most remarkable of these interments was that of a great tumulus on Langton Wold, which separates the Birdsall valley and the chalk wolds from Malton and the Vale of Derwent. This barrow is stated to have contained near the surface a series of Anglo-Saxon interments, underneath which were other important interments, supposed to be British. A few feet from the centre of the barrow, a stone wall was found, formed of flat stones laid edgewise, and in a direction nearly north and south. In digging away the stones of the wall, towards the centre of the tumulus, a skeleton was found, which proved to be that of a very tall man. The body had been laid on its left side, with the knees doubled up. More than one other skeleton was found which had been interred in the same manner. One was that of a female, which was laid on its left side, also with the knees drawn up. The body had been surrounded and covered with stones so as to form a rude cist, and the personal ornaments of the deceased had been buried with her. These were three cowry shells, and extraordinary numbers of the red-striped small snail-shells, one jet bead, three bronze bodkins, part of a belemnite,

ground and polished like a small roller, a bone ornament pierced for hanging or stringing, a large semicircular bone pin, and some other small articles of less importance. Another interment of a female was afterwards found in the same tumulus, similarly placed on its left side. We are inclined to think that these two ladies were anything but, what the newspaper account gives of them, "British Matrons." There are no circumstances in the description of them which are not found in the early Anglo-Saxon—we should say in this case, Anglian interments. The Anglo-Saxons did sometimes lay their dead in the grave on the side with the knees bent up; we have observed it ourselves in more than one instance in the Anglo-Saxon cemeteries of East Kent, and the only body we ever dug up in an Anglian cemetery to the north of the Humber—at Seamer, near Scarborough—was laid on its left side, with the knees doubled up towards the chin, and an unmistakable Saxon knife by its side. Perhaps the Angles of Northumbria buried in this form, when they did not burn their dead. The Angles in Britain practised both modes of interment. Again, the cowry-shell—the oriental cowry, usually—is especially characteristic of Anglo-Saxon graves, and has been found not at all unfrequently in those of Kent. The jet bead, too, the bronze pins, and the objects in bone, are all characteristic of Anglo-Saxon interments. We ourselves have great difficulty in believing in any mixture of Anglo-Saxon with Ante-Roman interments. But this question leaves great room for further investigation, and we look forward with great interest to Mr. Greenwell's promised book, which we are satisfied will be a very valuable contribution to archæological science. T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

THE BRITISH ASSOCIATION.

In the last number of the Intellectual Observer we stated that we should give accounts of such of the more important discoveries brought forward in the different sections as had not been hitherto described in our pages.

One of the most important applications of science illustrated at the last meeting was the mode of converting pig-iron into malleable steel by the Bessemer process. This is performed in instruments termed converters; these are lined with fire clay, and are so constructed that blasts of air can be forced in sixty or seventy streams through the melted pig-iron, which is poured into them. The air is forced in at a pressure of 20 lbs. to the square inch, and is sufficient to overcome the pressure of the melted metal, and prevent its entering the openings through which the air enters. The

air, in passing into the fluid metal, divides itself into innumerable small globules, which pervade the whole of the metal. As atmospheric air contains oxygen, and fluid cast iron contains about four per cent. of carbon, it results that the oxygen of the atmosphere at once unites with the carbon of the iron, producing an intense combustion. By this means a very rapid increase of heat takes place. The iron thus acquires a continual increase of temperature until it arrives at a point hitherto wholly unknown in metallurgical operations. The greatest heat of our furnaces only suffices to render malleable iron sufficiently soft to be indented with the heavy blows of a powerful hammer; but in this process the temperature is so immensely increased beyond that point as to retain the malleable iron in a fluid state. While this increase of temperature has been going on, the large quantity of carbon present in cast-iron, to which it owes its black and brittle character, is removed; and when the whole of the carbon has been thus eliminated from the metal, a known weight of carburet of iron—*i. e.*, pig-iron of a pure quality—is added, so as to restore such an amount of carbon as will constitute steel of the desired quality. The metal, after this admixture, is poured into a casting ladle, and run into moulds. By this means blocks of steel of any desired shape or size are rapidly made. The steel in a heated state can be taken to the rolling-mills or hammers and then fashioned in the ordinary manner.

An interesting paper was read in the chemical section on the action of light on sulphide of lead, having especial reference to the preservation of paintings in picture galleries. Dr. D. S. Price found that white lead pigments were not darkened by sulphuretted hydrogen except where they were shielded from the direct action of light, and he also ascertained that a white painted board that had been exposed to sulphuretted hydrogen until it had acquired a dark brown colour, was bleached in eight days by exposure to light, and that portions covered by opaque objects remained unchanged in colour, and that those parts protected by coloured glasses were protected from the bleaching action of the light in proportion to the opacity of the tint.

Dr. Price also found that the bleaching effect of light or darkened white lead was much more strongly marked when the pigment had been mixed with drying oils, as is the case in oil paintings, and that when employed in water-colours the effect is slower and less decided. In order to show the advantageous effect of light in the preservation of oil paintings, Dr. Price had a picture painted, and then exposed it to the action of sulphuretted hydrogen till it became much discoloured, and apparently destroyed. Strips of dark paper were then secured across the picture so as to cover some parts, and it was exposed to light for a long time. The parts of the picture exposed were perfectly restored to their original appearance, but those protected by the paper remained deeply discoloured and obliterated.

From these experiments Dr. Price came to the conclusion that it is most advantageous to have picture galleries well lighted, especially in towns were the air is charged with sulphur compounds, and that

it was quite a mistake to hang curtains in front of pictures with a view to their protection.

Mr. Pengelly made some very interesting observations on the insulation of St. Michael's Mount, Cornwall, which is now an island at high tide, and a peninsula at low water. The early British name of the mount signifies the "hoar rock in the wood," a description that is no longer applicable; but the change must have taken place before the time of Diodorus Siculus, who wrote 9 B.C., as he described the mount as it exists at present. Mr. Pengelly rejected the theory that the rock had been insulated by the encroachment of the sea, and maintained that its present condition was due to a general subsidence of the land. In the observations which followed the reading of the paper, Sir Charles Lyell supported the views of Mr. Pengelly, and said that there had been considerable changes of level since the ancient workers in tin had carried on their labours. There had certainly been a submergence and deposit, and then a re-elevation of many parts of the country since that time, and that the proof of this was highly interesting as showing that great changes had been effected in the condition of the globe during the human period.

Among the improvements in practical science brought forward at the Association, may be described the utilization of blast furnace slag as practised in France and Belgium. The plan there pursued is to run the slag direct from the furnaces into a pit eight or nine feet in diameter, and three feet in depth; in these it is allowed to cool slowly, which requires eight or nine days, when the solid mass is removed and cut into slabs of the required size for paving stones, for which purpose it is used in many of the towns of France and Belgium, and some of the streets of Paris, and is found to be superior to the sandstones and grits usually employed in those countries where there is a great deficiency of good paving stones. Whether the plan would answer conveniently in this country remains to be proved, as we possess a greater supply of good stones, and the space required for the pits would be a serious drawback to the introduction of the process, and there is much difference in the slags from different furnaces.

The unstable equilibrium of the elements of gun-cotton was strikingly shown by some experiments detailed by Mr. Scott, who found that either of the metals, potassium or sodium, produced an immediate explosion of this substance even when in a perfectly anhydrous condition, none of the other metals appeared to possess the same power as those of the alkalies, and even an amalgam of potassium or sodium is inert. The singular result of the contact of potassium or sodium with the cotton appears due to direct chemical action, and not to the presence of water or moisture inflaming the metal. It may be stated that gun-cotton is now being manufactured for use in ordinary breech loaders by Messrs. Prentice, and is found to be perfectly safe and to possess a higher penetrating power, and to cause much less recoil than common gunpowder.

ENTOMOLOGICAL SOCIETY.—*Oct.* 2.

FOSSIL INSECT IN THE DEVONIAN STRATA OF NORTH AMERICA.—At the last meeting of the Society Mr. Samuel Scudder, Secretary of the Natural History Society of Boston, U.S., exhibited fossil impressions of a gigantic *Ephemera*, which must have measured five inches across the full expanse of the wings; these impressions along with others had been found in the Devonian strata of North America, and were the earliest known records of insect life on the globe.

NOTES AND MEMORANDA.

VEGETABLE TRANSFORMATIONS.—M. Trécul has a paper in *Comptes Rendus*, detailing experiments and observations which he thinks shew that the organic matter contained in certain plant cells can transform itself, during putrefaction, into living bodies, differing from the species generating them. He tells us that in the bark of the elder (*Sambucus niger*), and in plants of the Solanum and Crassula families, there are to be found utricles full of little tetrahedrons, containing amylaceous matter, and that he has seen these bodies elongate themselves by one of their angles, and gradually form a peculiar plant by producing a cylindrical stem.

THE SPIRAL VESSELS OF PLANTS.—M. Lertiboudois states, in *Comptes Rendus*, that the spiral or tracheal vessels of plants may not only contain air, but be traversed by fluids capable of solidification. In one instance he found the large vessel in the centre of fibres of the *Calamus Rotang* full of a white solid substance, composed of cylinders of variable length. Placed in water this material resolved itself into granules, which exhibited a lively motion.

PHARAOH'S SERPENTS.—The amusing chemical playthings, lately introduced and so named, are said to be composed of sulpho-cyanide of mercury, and their peculiarity consists in the extraordinary volume of ash which they pour forth in a serpentine form, as soon as they are ignited. They are highly poisonous, and it would be unadvisable to allow the air of a sitting room to become too full of their fumes. Cyanogen, or "blue producer," as the name implies, is an essential constituent of Prussian blue. It is a compound of carbon and nitrogen, in the proportion of twelve by weight of the former to fourteen of the latter. At ordinary pressure, cyanagen is a transparent gas; under a pressure of four atmospheres a liquid, and may be frozen at —30° into a crystalline solid. It forms a series of important compounds—that with hydrogen is hydrocyanic, or prussic acid. With sulphur it forms sulpho-cyanogen, the compounds of which are called sulpho-cyanides,

THE MOON ECLIPSE, 4TH OCT.—In Paris, according to Messrs. Goldschmidt and Flammarion, this eclipse was very well seen, and the radiating lines from Tycho and other mountains in the obscured parts were distinctly visible, as were also the margins of the various craters. In the neighbourhood of London the same facts were noticeable, and the copper-coloured light on the eclipsed portion was unusually striking, from the extreme fineness of the weather. It looked as if a cap of dark but luminous copper-coloured smoke was slowly drawn over part of the moon's face. The refractive power of the earth's atmosphere is said to be the cause of this phenomenon.

THE MAGNETIC STORM IN AUGUST.—The great magnetic storm, which began on the 3rd August, commenced very suddenly, and was felt simultaneously at Kew and Lisbon. The needle was violently agitated. The storm, after a period of repose on the second day, broke out again. In general character it resembled the magnetic storm of 1839, and on both occasions the sun exhibited large spots rapidly changing their appearance.

London from a Balloon.—In Mr. Glaisher's October ascent, the long lines of gaslit streets produced a very splendid effect, like a brilliant milky way, but more golden. The reflection of the gaslights from the clean pavement of Regent Street had the appearance of a glistening silver band. Observations of this class may assist us in interpreting some of the telescopic appearances of the moon, as regards their luminosity and colour.

A Magnesium Battery.—M. Bultinck, of Ostend, describes to the French Academy, experiments which he made, substituting magnesium for zinc, in a voltaic combination. A chain of twenty elements, combined like those of Pulvermacher, gave striking effects when simply moistened with water.

Animal Grafts.—M. P. Bert gives to the French Academy further accounts of his remarkable animal grafts, such as making the tail of a rat grow on another creature. The end of the tail is skinned and introduced in the subcutaneous tissue. An effusion of plastic fluid takes place, and fibres soon appear. On the fourth or fifth day, capillary vessels have united the vessels of the graft and the creature in which it is placed. At a later period these vessels became larger. In the course of twenty days, the muscular fibres experience fatty degeneration. The nerves exhibit a double process of degeneration and regeneration. The bony and cartilaginous parts undergo little change. If the tail is a young one it completes its growth in its new position, and may even surpass the dimensions it would have normally reached.

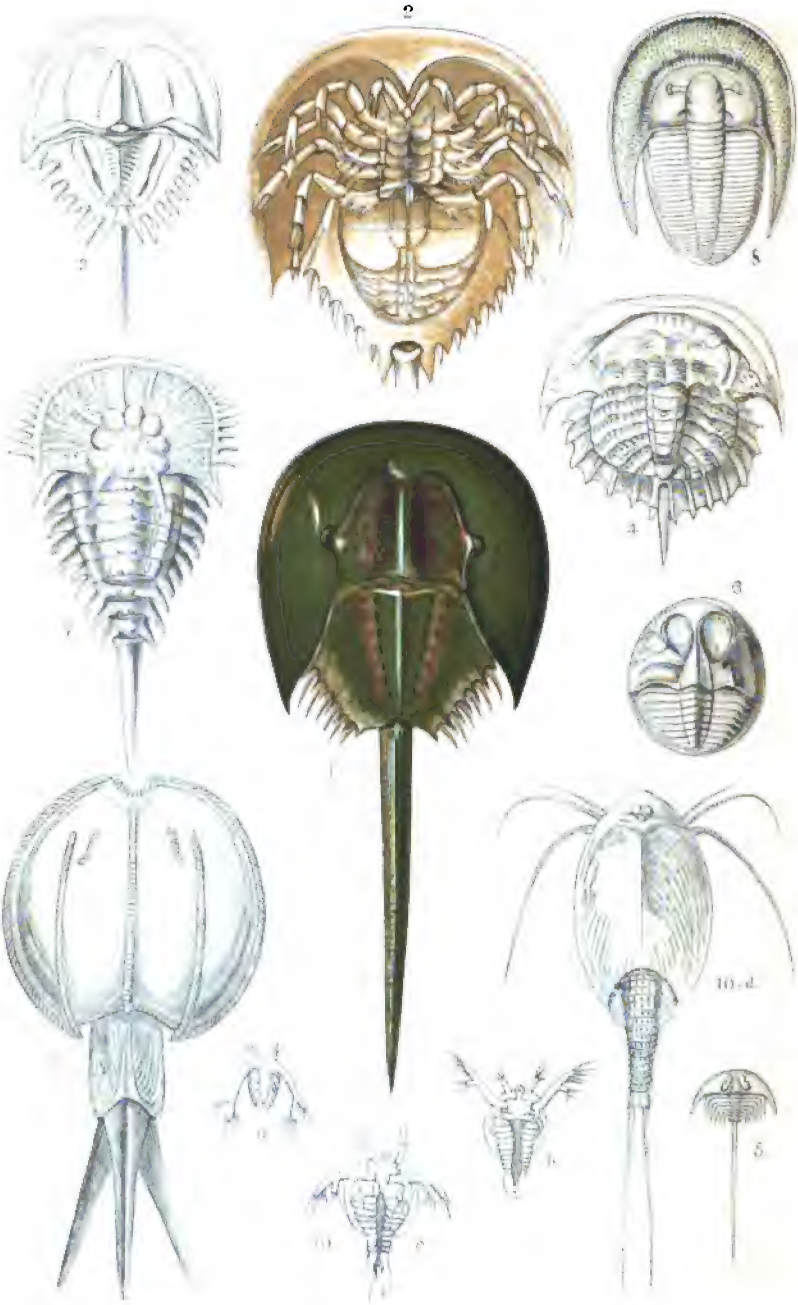
Clarification of Water.—Mr. Jennet states that in the well known plan of clarifying muddy water by the use of alum, that the alum doubles itself into sulphate of potash, which is found in the clear water, and into sulphate of alumina, which exerts the clarifying action as it decomposes, its earthy base forming an insoluble precipitate which drags down with it the mechanical impurities. Sulphate of alumina is equally useful as alum (sulphate of alumina and potash), and in smaller quantities. Alum being used in the proportion of four-tenths of a gramme to a litre, and sulphate of alumina as a substitute for alum in the proportion of seven to ten.

The Long-Eared Bat.—Mr. Sowerby, writing in the *Annals of Natural History*, describes how one of these animals, confined in a wire gauze cage, captured his prey. The wing membrane extends from the hind legs to the tail, "forming a large bag or net, not unlike two segments of an umbrella, the legs and tail being the ribs." To catch a large fly the bat threw his body on it, drove it into this bag, and devoured the fly at leisure.

The Water Shrew.—Mr. N. L. Austen describes in the *Annals of Natural History* the habits of a pair of water shrews, which he kept in a large cage, like a dormouse cage, with a bath in it. They did not appear timid, and readily ate their food. When minnows were put in the bath, they plunged in after them, each securing a victim, which he killed by biting through the head. In feeding they held the fish firmly between their fore paws, as an otter does. The ears of shrews are furnished with three valves, which fold together when they dive, and keep the water out.

Variations of Human Muscles.—Mr. John Wood describes in the *Proceedings of the Royal Society*, No. 77, cases of variations in human myology observed during the dissection of thirty-six subjects in King's College Hospital. The paper is too technical for its details to be understood by any but those acquainted with anatomy; but it establishes two interesting facts—first, that important variations from the normal type do occur, and, secondly, that in some cases they exhibit characteristics found in monkeys, bats, moles, birds, and sloths.

85th Planet.—Dr. Peters, of Clinton, U.S., has discovered another planet, 10 mag. At the end of September its position was R. A. 12° 43′ 5″ 3, D. + 11° 22′ 5″ 9.



SHIELD-BEARING CRUSTACEA.

(Recent and Fossil.)

THE INTELLE[illegible]

SHIELD-[illegible]

BY [illegible]

[illegible] to discover the str[illegible] [illegible] is the [illegible] must be [illegible] which [illegible] not only [illegible] have now entirely [illegible] to [illegible] and, as [illegible] [illegible], before we can arrive [illegible].

Among the diverse types of [illegible] the *Crustacea* [illegible]; for they [illegible] and are marked by characters [illegible] that they are [illegible] distinguished [illegible] in a fossil as well as in a recent state.*

The *Crustacea* belong to [illegible] first class of which includes [illegible] nides (spiders, scorpions, etc.) [illegible] lobsters, etc.): the fourth [illegible] Worms (*[illegible]*).

Great as may at first [illegible] to be between the perfect insect [illegible] with [illegible] locomotion, and the worm, [illegible] rem[illegible]

* Even the anomalous [illegible] in their [illegible] condition, [illegible] examination [illegible] may be observed in this class, [illegible] similar metamorphoses to those of the higher orders.

THE INTELLECTUAL OBSERVER.

DECEMBER, 1865.

SHIELD-BEARING CRUSTACEA (Recent and Fossil).

BY HENRY WOODWARD, F.G.S., F.Z.S.,

Of the British Museum.

(*With a Coloured Plate.*)

To discover the structure and investigate the anatomy of organic beings is the life-task of every true naturalist. And not only must he study the living forms of to-day, but also those which existed in the bygone ages of geologic time. For palæontology not only makes us acquainted with forms which have now entirely disappeared, but also with others which belong to still existing groups; all of which, however, fill up, and, as it were, fit into, vacant places in the series, and are needed, before we can arrive at a complete conspectus of any one class.

Among the diverse types of living forms, few, if any, exceed the *Crustacea* in interest; for they claim an antiquity so remote, and are marked by characters so varied, and yet so typical, that they are readily distinguished from all other classes, both in a fossil as well as in a recent state.*

The *Crustacea* belong to the sub-kingdom ARTICULATA, the first class of which includes the Insects; the second the Arachnides (spiders, scorpions, etc.); the third the *Crustacea* (crabs, lobsters, etc.); the fourth, Worms; and lastly, the Internal Worms (*Entozoa*).

Great as may at first sight appear to be the difference between the perfect insect, endowed with powers of aërial locomotion, and the worm, yet it will be remembered that in

* Even the anomalous Cirripedia, the "barnacles" and "acorn-shells," show in their adult condition, on close examination, evidence of crab-character that can only be observed in this class, whilst in their larval stages they pass through similar metamorphoses to those of the higher orders.

the *larval* state the worm-like caterpillar or grub precedes the *imago*.

In the *Crustacea* almost as great a diversity exists between the highest and lowest orders as between the worm and the butterfly; but the *larval stages* of the higher forms are found closely to simulate the *adult state* of some of the lower, and seem to suggest that the latter are only the arrested stages of the former—with powers of reproduction added.

In the *Mammalia* (the highest form of *Vertebrata*) the bony framework is internal, being clothed with muscles, to which it gives firmness, and furnishes points of attachment and *fulcra*.

This is a living framework, moreover, and is kept in repair and supplied with blood-vessels which nourish it; for it has to last the lifetime of the individual.

In the *Crustacea* (which may serve as an example of the *Invertebrata*), on the contrary, the framework is external, the dermal cuticle being hardened by the deposition of calcareous matter and chitine, and within this, as in a coat of mail, the soft organs are placed, and to it the muscles of the animal are attached.

This is not, however, a permanent, but a deciduous skeleton, being cast off and reproduced as often as the growth of the creature necessitates its increased size.

These two forms, the Mammalian and Crustacean, are types of the endo and exo-skeleton (the internal and external).

In the endo-skeleton the nervous centre is placed upon the dorsal surface, and the nutritive system on the ventral; but in the exo-skeleton the reverse is the case, the viscera being placed along the back, and the nervous ganglia down the ventral surface.

Again, in the *Vertebrata* the principal development of sentient power is concentrated to form the brain, which is the capital of the whole nervous system: in the *Annulosa*, however, each separate ring or segment of the body has its own ganglion or nerve-mass, and each ganglion, in the simpler forms, seems equal to every other, and there is no specialization of any. But this simplicity of structure gives way to more complex forms as we ascend in the animal scale.

In insects the body is said to be composed of thirteen rings—head, one; thorax, three; abdomen, nine; but entomologists know that the head in insects is in reality made up of at least four segments blended together; for it is a fundamental rule in the *Annulosa*, that every body-ring bears one pair of appendages, and *only one* pair. Therefore, if we find an insect's head, bearing eyes, antennæ, maxillæ, and mandibles, we shall be quite safe in concluding that it is made up of several segments soldered together.

The type-number of segments in *Crustacea* is reckoned to be twenty-one—head, seven; thorax, seven; abdomen, seven. But here the same rule holds good; namely, that wherever more than one pair of appendages is found to a segment, that is not a simple, but a compound ring.

The combination of several segments to form one division—as the head, for instance—results in the production of a more highly-organized form, by the union of the separate nerve-masses, or ganglia—which in the lower forms remain separated—and thus a superior mass is formed, bearing some relation to the brain in the vertebrates.

Thus, in the crab, we find the body composed of a cephalo-thorax (produced by the soldering together of the first fourteen rings), and an almost rudimentary tail or abdomen.

In this division, as might be expected, we meet with those most highly-organized forms, the land-crabs, and semi-aquatic, and freshwater species, all possessing a high degree of development as compared with other members of the groups to which they belong.

Although the coalescence of the nervous centres is a point of so much importance, yet we must not allow it to supersede more general considerations of structure and habits, when treating of the Invertebrata.

For example, we find in the classification of the *Crustacea*, that the *Maia* and its allies, the triangular crabs, are placed before *Gonoplax*, *Grapsus*, and *Carcinus*—genera which display in their habits a high degree of activity and intelligence. But any one acquainted with the dull, lethargic habits of the triangular crabs (many of which, as *Hyas* and *Maia*, for instance, remain so long sedentary, that their carapaces and limbs become coated with living growths of nullipore, corallines, and sea-weeds) cannot for a moment doubt that the lively shore crab (*Carcinus mœnas*) ranks far before them in reality, however they may be placed in books.

If you refer to the plate you will find a series of Crustacea figured, not all belonging to the same order, but having a strong resemblance to each other in respect to the general form of their shelly covering, in allusion to which I have spoken of them here as Shield-bearing Crustacea.

They include the *Phyllopoda*, the *Trilobita*, the *Pœcilopoda*, and the *Eurypterida*.

The Phyllopods are represented in our engraving by the fossil genus *Dithyrocaris* (Fig. 9), and the recent freshwater *Apus* in its larval and adult stages (Fig. 10 *a*—*d*).

The Trilobites, by the curious Bohemian species of *Harpes ungula*, from the Upper Silurian formation (Fig. 8).

The Pœcilopods, by the two recent species of King-crabs

(Figs. 1 and 2), and by four fossil forms which carry us back in time, first, to the period of the deposition of the Lithographic Limestone, and the era of the *Archæopteryx*,* and Pterodactyles,† with long tails (Fig. 3); and then, still further back, to the great Carboniferous epoch, when the Coal-measures were accumulated (Figs. 4, 5, 6).

Lastly, the Eurypterids, which are here represented by a newly described genus ‡ (*Hemiaspis*, Fig. 7) from the Lower Ludlow Rock of Leintwardine, Shropshire, and have been illustrated on a former occasion in this work by the genus *Slimonia*§ from Lanarkshire.

In a chart of Fossil Crustacea,|| recently engraved by Mr. J. W. Lowry (and to which we are indebted for Figs. 3—9 of our plate), we are for the first time introduced to a general view of this ancient class of Articulate animals.

By a reference to this chart it will be seen that the oldest order in time is that of Trilobites, which are characterized by the trilobed form of the trunk-segments (as well seen in *Harpes*, Fig. 8), the possession of sessile compound eyes—in most—and the entire absence of limbs of any kind. With nearly all species is found an articulated *labrum*, or lip-plate, attached by its anterior margin to the under-side of the front border of the head.

The rest of the animal must have been clothed in thin membrane only, as up to the present time no trace of limbs or other organs has rewarded the diligent search of Barrande, Salter, Angelin, and a host of others who have essayed to find them.

The next oldest group will be found to include the bivalved and shield-bearing forms, the *Ostracoda* and *Phyllopoda*; the former represented by the little *Cypris*, so abundant in all our freshwater ponds, and commonly to be seen in every aquarium; the latter by the recent *Apus* (Fig. 10) and the fossil *Dithyrocaris* (Fig. 9).

Beneath the shield-shaped covering can be seen an articulated *labrum* attached, as in the Trilobites, to the under-side of the frontal portion of the carapace. Against the sides of this labrum the jaws, armed with serrated teeth, are attached, by means of which the food is triturated. Then follows the lower lip, as it is called, and next a pair of branched and finely articulated swimming feet, followed by a series of about thirty

* See the INTELLECTUAL OBSERVER for December, 1862, vol. ii. p. 313, and plate.

† See the INTELLECTUAL OBSERVER for January, 1863, vol. ii. p. 443.

‡ See *Quart. Journ. Geol. Soc.*, Nov. 1865, vol. xxi. p. 490, plate 14, fig. 7.

§ See the INTELLECTUAL OBSERVER for Nov. 1863, vol. iv. p. 229, plate and woodcuts.

|| A new chart of Fossil Crustacea (accompanied by a descriptive Catalogue), arranged and drawn by J. W. Salter, F.G.S., and Henry Woodward, F.G.S., F.Z.S. Engraved by J. W. Lowry, published by J. Tennant, London, Sept. 1865.

pairs of leaf-like appendages (gill-feet) which serve the office of branchiæ, and by their constant vibratory motion enable the animal to move freely through the water. When the shield is removed, the body is seen to be composed of a head bearing the eyes and thirty-three segments, terminated by a telson (or tail-plate), bearing two long many-jointed appendages. The first thirteen segments are quite soft and worm-like on their upper surface, being protected beneath the broad head-shield, the rest are ornamented with six or eight little spines along the posterior margin of each joint. All but the last six bear gills upon their under surface. The eleventh pair of feet are modified so as to form egg-pockets (ovaries), for the preservation of the eggs until the young are hatched.

We find traces of the appendages in *Ceratiocaris,* and in both *Ceratiocaris* and *Dithyrocaris* the jaws * are preserved in a fossil state.

There are several points in the structure of Trilobites which indicate a close relationship to the Phyllopods.

We find in both the articulated labrum, and although in the former (Trilobites) we do not find foot-jaws, it does not certainly follow that they had none, although the negative evidence has hitherto seemed to favour that view.

In both a greater number of segments is attained than is usual in the Crustacean type. Thus in *Conocephalus* there are sixteen (reckoning one each for the head-shield and pygidium); in *Paradoxides* twenty to twenty-two; in *Arethusina* twenty-two; and in *Harpes* (Fig. 8) twenty-eight; and if we look upon the head-shield and tail-plate as composed of several body-rings joined together, which seems certain, we have forms presented to us in which the multiplication of segments like each other is one of its leading features, illustrating that kind of growth which Professor Owen has most aptly called vegetative repetition of parts.

The next oldest group in time is found to be the *Eurypterida,* represented in our plate by *Hemiaspis* (Fig. 7), and *Slimonia* (see Plate in INTELLECTUAL OBSERVER, vol. iv. p. 229).

It is unnecessary here to enter upon a detailed description of *Slimonia,* that genus and its allies having already appeared with illustrations in the article before mentioned. But the genus *Hemiaspis* offers some new points of structure and affinity which are deserving of notice.†

The great interest attached to this new genus is, that it appears to offer just the link we needed to connect the *Xiphosura* (King-crabs) with the *Eurypterida.*

* See my article on Crustacean teeth in the *Geological Magazine* for Sept., No. 15, vol ii. p. 401, plate xi.

† See article in *Quart. Journ. Geol. Soc.*, Nov. 1865, vol. xxi. p. 400.

Limuli, apparently differing but little as regards the carapace from the recent species of Molucca and America (see plate, Figs. 1 and 2), occur as early as the deposition of the Solenhofen limestone in Bavaria (see plate, Fig. 3); and in the Coal-measures of England and Ireland, several species of *Bellinuri* occur (see plate, Figs. 4, 5), in which the cephalic shield is composed of the cephalo-thorax; and the segments of the abdomen, if not anchylosed in all,* are so in most.

But in *Hemiaspis limuloides* we have the cephalic, thoracic, and abdominal divisions still remaining distinct, and apparently capable of separate flexure. This important character at once separates it from *Limulus* and *Bellinurus*.

It will also be observed that *Hemiaspis* is, in general appearance, strongly severed from the other species of *Eurypterida*, as well as from the *Xiphosura* in structure. The three divisions into head, thorax, and abdomen are more strongly marked. The abdomen is reduced to very slender proportions (less than one-third the breadth of the thoracic plates), and the telson, or tail-spine, is nearly one-third the length of the entire animal.

The carapace in general outline resembles *Limulus*, but is more dilated laterally.

The glabella, or central portion of the shield, is ornamented with tubercles.

The thorax is composed of six strongly trilobed segments, the *epimera* (lateral portions) being equal in breadth to the central portion of each segment.

These segments present a striking analogy to the trunk-segments of a Trilobite.

The abdomen consists of only three segments, the second and third having small bilobed epimeral pieces.

If we regard the first six body-rings as thoracic, and the remaining three segments as abdominal, we must presume that each of these latter is a double segment, as compared with the segments of the *Eurypterida* proper. (See plate of *Slimonia*, vol. iv., p. 229.)

On the other hand, the presence of these three segments precludes our considering the head to be the cephalo-thorax, and the succeeding segments the abdomen, as in the *Xiphosura*.

The smallness of the abdomen, and its reduction from the assumed normal number of six segments to three, seems to indicate a form by which, with the help of others, we may bridge over the interval that has hitherto existed between these two groups, the *Eurypterida* and the *Xiphosura*.

* In *Bellinurus regina* (Fig. 5) the abdominal segments are considered by Mr. Baily to be moveable.

With the appendages of *Hemiaspis* we are unacquainted; but the genera *Pterygotus*, *Slimonia*, and *Eurypterus*, are so well preserved to us that we are able to restore them in the most perfect manner from actual specimens.

Their appendages offer striking analogies to the *Limuli*, but at the same time we cannot neglect to notice their strong resemblance to the scorpions among the *Arachnida*.

But these fossil genera seem to have been truly marine, and to have performed their respiration by means of branchiæ, as in the recent king-crabs; the scorpions, on the contrary, are furnished with tracheæ for the purpose of aërian respiration, as in insects, a most important distinction.

We are led to regard this order as a more generalized type of *Crustacea* indicating, in Silurian times, if not representing, the *Arachnida* of the present day.

In *Limulus* we are introduced to a more compact form of organism in which the body segments are concentrated into two parts, the cephalo-thorax and abdomen; and lowly as the king-crabs appear in comparison to the Decapods (crabs and lobsters), yet they must be looked upon as a more exalted type than the *Eurypterus*, and its fossil allies, according to the laws of cephalization, as propounded by Dr. Dana and other carcinologists.

The "King-crab," or "Moluccan crab" (*Limulus*), is one of the most persistent types of organisms we are acquainted with higher than the Mollusca. For we cannot, I think, doubt that the king-crab of our modern seas is descended from those of the Jurassic formations of Germany, although none are found in intervening rocks.

Had *Limulus* represented a higher type, it is hardly conceivable that it could have existed so long, and apparently unchanged. But it seems to belong to one of those eccentric groups that appear from time to time in the zoological series, which, branching out into a by-way of its own, is checked from further onward progress; but being possessed of tenacity of life and great powers of reproduction, holds its ground, whilst higher orders are being modified or swept away.

That the king-crabs present analogies with the Trilobites few will doubt, especially when we compare them with the Carboniferous species, such as *Limulus* (?) *trilobitoides* (Fig. 6), a remarkably trilobed form.

Mr. Salter, in his *Monograph on the Trilobites* (Palæontographical Society, 1864, page 8), writes:—"Every author who has written on Trilobites has more or less perceived their analogy with the *Limulus*, or king-crab, to which there is, indeed, a good deal of external resemblance. But this resemblance totally fails when we examine the under-side of the

animal; for all the researches hitherto made (and they are many) fail to detect the slightest trace of limbs in the Trilobites. It is impossible, seeing the state of preservation in which they occur, to suppose that in every case—in fine shale, in limestone, in arenaceous mud—all traces of these organs should have been lost, had they ever existed." Mr. Salter considers (op. cit., p. 9) "that they probably lay half-buried in the silt, as is the frequent habit of the large *Limulus*, or king-crab."

The same author notices "The curious *facial suture*" (which separates the elements composing the head, dividing the cephalon into the central part, or *glabella*, and two lateral portions (cheeks), which bear the eyes)—"a line of division only faintly indicated in the *Limulus*, and which has, perhaps, no other representative in the whole Crustacean class."

"Limulus," Mr. Salter adds, "also shows a trace of trilobation; but it is accidental, rather than characteristic, in other groups."

There is only one key left to us by which to unlock these mysterious interblendings of forms belonging to distinct orders, and even classes; it is *Embryology*.

In the young state the larvæ undergo repeated moults, presenting, in the course of their progress to the adult, a series of forms totally unlike the parent, but bearing a resemblance either to the larvæ, or to the adult condition of some other genus. This is illustrated by the figures of *Apus* in our plate, the larval stages (Fig. 10, *a*, *b*, *c*,) fitly representing some of the earliest of our fossil disc-bearing Crustacea, *Peltocaris*, etc.

I hope to say more upon the subject of the larval stages of Crustacea in a future paper. Whether we view these remarkable modifications as so many separate indications of creative design, or, as resulting from the influences of food, climate, locality, and a host of other circumstances, acting upon the race for immeasurably long periods of time, the result we see around us must be the same, namely, an endless diversity of forms in every class of the animal kingdom, adapted to suit all the varied exigencies of animated existence.

EXPLANATION OF PLATE.

Fig. 1. The King-crab, *Limulus Moluccanus*, Fabr. (dorsal surface), $\frac{1}{8}$th the natural size; abundant on the coasts of Molucca, China, and Japan.

Fig. 2. *Limulus polyphemus* (ventral aspect), about $\frac{1}{6}$th the natural size; common on the east coast of North America.*

* For a description of the organs of *Limulus*, see article "On the Seraphim and its Allies," INTELLECTUAL OBSERVER, vol. iv., p. 233.

Fig. 3. *Limulus Walchii,* Desmar., $\frac{1}{8}$th the natural size; from the Lithographic stone of Solenhofen, Bavaria.

Fig. 4. *Bellinurus* (*Limulus*) *rotundatus,* Prestw., $\frac{2}{3}$rds the natural size; Coal-measures, Coalbrook-dale, occurring in pebbles of clay-ironstone.

Fig. 5. *Bellinurus reginæ,* Baily; Coal-measures, Ireland.*

Fig. 6. *Bellinurus* (*Limulus*) *trilobitoides,* Konig.; Carboniferous Limestone, Ireland.

Fig 7. *Hemiaspis limuloides,* H. W. (the natural size); Lower Ludlow rock, Leintwardine, Shropshire.

Fig. 8. *Harpes ungula,* Sternberg (the natural size); Upper Silurian, Bohemia.

Fig. 9. *Dithyrocaris Scouleri,* McCoy; Carboniferous Limestone, Ireland.

Fig. 10. *Apus cancriformis,* Schæffer; recent; living in freshwater lakes, Bohemia.

Fig. 10, *a. b. c.* Different degrees of development of the larval *Apus* (after M. Zaddach).

Fig. 10, *d.* Adult female, natural size (dorsal aspect).

CYCLONES.

BY A. S. HERSCHEL, B.A.

The revolution of the earth about the sun, its globular figure, and its daily rotation on its axis, occasions its variety of climates, its day and night, and its regular succession of the seasons. The trade winds, anti-trade winds, and monsoons are at the same time set in motion, as well as land and sea breezes, and keep up a constant agitation in the atmosphere; by which the local moisture, temperature, and density of the atmosphere are disturbed and rendered unstable. Its strata become the scene of shifting winds, and are often dislocated by tempests of the most violent kind. The most violent of these tempests are conformable to a certain law, called—perhaps in default of a better term—"the law of storms." Readers of the Intellectual Observer who regard it as a barbarism to couple the idea of law and harmony with anything so lawless as a storm, may substitute for this expression, wherever it occurs, without selection, the "theory of cyclones."

The damage occasioned by hurricanes, like the destruction caused by earthquakes or volcanoes, is incalculably great. To

* See explanation of sheet No. 137, p. 12—14, "Geological Survey of Ireland, 1859."

discover the law, if not of their production, at least of their progress, must accordingly be regarded as one of the greatest benefits to navigation. In pursuit of this laudable object, by carefully examining the log-books of vessels overtaken in these winds, Capper, Piddington, Redfield, and Reid were first led to discover the theory of cyclones, which, brought under a simple point of view by Dové, has since acquired a scientific form, and, to navigators at least, a character of the greatest importance. Navigators who avail themselves of this knowledge enjoy superior facilities, and possess greater immunity from danger on the seas than their forefathers of the last generation could have possibly foreseen.

While the "highway of nations" was thus rendered more safe, and communication between distant countries was remarkably facilitated, a system of meteorological telegraphy on land, begun as early as the year 1856, was made to connect the towns of Brussels, Geneva, Madrid, Rome, and Turin, besides several towns in France, with Paris. In the hands of its promoter, Mr. Le Verrier, it offers facilities for extending yet further the law of storms, in a manner which, in the sequel of this article, will be explained. A similar system in the Netherlands was undertaken in the year 1860, where four towns, Mästricht, Gröningen, the Helder, and Vlissingen, now regularly transmit their daily observations of the weather, by telegraph, to Utrecht. The example thus set was followed by other countries. Towards the end of the year 1860, a more perfect system of telegrams than any yet in use, including coast-warnings in the case of storms, was introduced into England by the late Admiral Fitzroy, whose barometers, and *Barometer Manual*, were already regarded as the greatest boon at many exposed stations of the coast. The project thus originally carried out consists of daily telegrams from about twenty British and neighbouring foreign ports, forming a daily "weather report" of the British Islands. Compared with the reports of the few preceding days, a "forecast," as it is called, of the weather is produced; and in the event of the passage of a dangerous storm, its track and rate of progress are announced by telegraph to the threatened ports, where the well-known cautionary signals of the "drum and cone" are exhibited, in time to warn mariners of the consequences of its approach.

The first coast-warnings, on this principle, were sent to Shields on the 6th of February; and the first weather-forecast was published on the 1st of August, 1861. Since then, continuously up to the present time, the Central Meteorological Office in London has kept a daily watch upon the weather. The results thus collected, and compiled in a series of valuable

papers by the late Admiral Fitzroy, are contained in his excellent work, the *Weather-Book,* from which many details in this article have been unavoidably and exclusively borrowed.

The first description of a great storm in England, after that of the great Armada in 1588, pretending to scientific accuracy, was written by De Foe, the celebrated author of *Robinson Crusoe, The Plague of London,* etc., entitled, *The Great Storm* of November, 1703. Many accounts of this storm appear in contemporary numbers of the *Philosophical Transactions.* The wooden lighthouse erected by Winstanley on the dangerous Eddystone Rock, near the coast of Cornwall, disappeared, while undergoing some repairs, in this storm, on the 26th of November 1703, and Winstanley, and all his assistants, thirty in number, perished in the sea. That actual hurricanes occasionally visit the British Islands there is reason, from the description of this storm, to believe. It will furthermore be seen, by what follows, that very destructive storms visited England at an interval of only a few years, in 1859 and 1863.

Lord Francis Bacon, and later, Dr. Halley, attempted very early to give a scientific explanation of the trade winds. Yet it was not until the year 1735 that Hadley described, in the *Philosophical Transactions,* the real origin of the trades. The law of storms, or theory of cyclones, is of still more recent date, and the subject of the variable winds appears first to have engaged the attention of Dr. Franklin in America about the year 1740. The following occurrence is narrated by himself, in a letter addressed to Mr. Alexander Small, under the date of May 12, 1760, printed in Colonel Capper's work on *Winds and Monsoons.* "About twenty years ago," Franklin writes, "we were to have an eclipse of the moon at Philadelphia, about nine o'clock. I intended to have observed it, but was prevented by a north-east storm, which came on about seven, with thick clouds as usual, that quite obscured the whole hemisphere; yet, when the post brought us the Boston newspaper, giving us an account of the same storm in those parts, I found the beginning of the eclipse had been well observed there, though Boston is north-east of Philadelphia about 400 miles. This puzzled me; because the storm began so soon with us, as to prevent any observation; and being a north-east storm, I imagined it must have begun rather sooner further to the north-eastward than it did at Philadelphia; but I found that it did not begin with them until near eleven o'clock, so that they had a good observation of the eclipse. And upon comparing all other accounts which I received from the other colonies, of the time of beginning of the same storm, and since that of other storms of the same kind, I found the

beginning to be always later the further to the north-eastward."

In this manner Franklin was first led to observe that the north-east storms of America came from the south-west.

The same peculiarity of these north-east storms was afterwards observed by Redfield, at New York, on the 3rd of September, 1821. Houses were unroofed at New York, and the wharves of the town were flooded thirteen feet deep in water. by a furious north-east storm, blowing from the quarter where Boston again is situated at a distance of only 180 miles. Yet the inhabitants of Boston, at this very time, were witnessing a successful balloon ascent; and the wind was not felt at Boston until five hours after the houses were dismantled at New York. These, and other observations of the same kind, led Redfield to the somewhat surprising conclusion, that the movement of the wind in these storms of the American coast is like that of a wheel, or of a disc laid flat—in other words, rotatory—revolving round a centre in a direction contrary to the hands of a watch. The centre of this storm, Redfield showed, was locomotive, commencing in the West Indies on the 1st, touching at New York on the 3rd, and disappearing off the coast of Nova Scotia, in the Atlantic Ocean, on the 4th of September.

Nine rotating storms were afterwards investigated by Redfield, and a chart of their central tracks was published in the *American Journal of Science* in the year 1835. At least twenty more, traced by Reid, Redfield, Piddington, and Milne, were soon added to the list of revolving storms, which happened in the North Atlantic Ocean in the first half of the present century. A chart of their tracks is given by Piddington in his *Sailor's Horn-Book,* than which no more complete work can be consulted on the "theory of cyclones."

From this chart it appears that hurricanes of the West Indies commence between 50° and 60° west longitude from Greenwich, and between 10° and 20° north latitude, not far from Barbadoes in the Windward Islands, to which the epithet "still-vexed" applies far more truly than to "Bermuthes," the island oäsis of the North Atlantic Ocean. Round Bermudas the storms sweep in a series of parabolic tracks, of which the Island of Bermudas itself is about the focus. They accordingly rarely traverse it, but their upper branches, more or less open according to circumstances, recurve towards the east between Bermudas and the mainland of America.

Another group of West Indian hurricanes, commencing about the same spot as the last, traverses the Caribbean Sea on straight-line tracks, towards the Gulf of Mexico, which they

enter, and produce upon the Mexican coast the furious winds called "*Los Nortes*" by the Spaniards.

Finally, a third group of revolving storms, consisting, like the last, of straight-line tracks, takes its rise in the centre of the American Continent, and crossing the great American Lakes to the Gulf of St. Lawrence, spreads itself eastwards over the North Atlantic Ocean. These last are winter gales, occurring in November, December, and January, while the hurricane-season in the West Indies is from August to October.

The word Cyclone (*κύκλος, a circle*), is chosen by Piddington to represent under one term the hurricanes of the West and East Indies, the Mauritius, and of the China Sea, and whatever other curved winds of the same kind are found to occur in different parts of the world. Reid and Redfield, Capper and Horsburgh, in the West and East Indies respectively, besides Piddington at Calcutta, and Dr. Thom at the Mauritius, have each investigated the law of storms in their own particular quarters of the globe, and have been led to the same conclusions. Among these names must ever be remembered that of the late Rear-Admiral Fitzroy, who so ably investigated the "Royal Charter" Storm, that "a better example for illustrating the subject is not likely to occur soon."

In all parts of the intertropical seas, cyclones take their origin near the equator. They thence progress towards the west, more or less rapidly, inclining towards the poles as they proceed, until, arrived beyond the tropical regions, they recurve in a wide, open sweep towards the east. A particular tract in the Southern Indian Ocean, called by Piddington "the storm tract," is the origin of the Mauritius cyclones; extending between 75° and 105° east longitude from Greenwich, and from 5° to 25° south latitude. Here cyclones make their appearance at the close of summer (from February until May), and, for an unexplained reason, often remain nearly stationary for four or five successive days. In general, their course is towards the west, with a speed of three to ten miles an hour, inclining towards the south as they advance. They sometimes attain the longitude of Rodriguez, Mauritius, and Bourbon, or even pass, southwards, between Bourbon and Madagascar, before they recurve towards the east. More commonly, they recurve in their course before attaining the longitude of these islands, and proceed towards the great Southern Ocean, in the direction of the desolate rocks of St. Paul's and Amsterdam.

Cyclones in the Eastern Indies occur about the changes of the monsoons, generally in the months of May and October. They make their appearance in the Bay of Bengal from 5° to 20° north latitude, and travel towards the west with a speed of three to sixteen miles an hour; meeting the east coast of the

peninsula more often near Calcutta than Ceylon. A few of these cyclones enter the Arabian Sea, and a few occur in the Sea of Andaman.

Typhoons, as the cyclones of the China Sea are called, are chiefly confined to the northern part of that sea, where they occur from July to November. They rise near the northern extremity of the Philippine Islands, and proceed westwards to the coast of Asia, between the Island of Hainan, and the latitude of Macao or Hong Kong. Their progressive speed is from seven to twenty-four miles an hour—nearly as rapid as that of the West Indian hurricanes; which travel from ten to forty-three miles an hour—the greatest progressive speed of all the intertropical cyclones.

At the centre of every true cyclone there is a calm spot, or "storm's-eye," as it is called, eight to ten miles wide, in which the air is calm, the sky, at times, is clear, and the sun by day, or the stars by night, are visible. About this part of the storm, the greatest depression of the barometer is always observed. A sudden rise of the mercury from this condition foretells, almost for certain, a violent return of the wind from the opposite direction.

"First rise after low
Foretells a stronger blow."

Around the focal calm to a distance of fifty to a hundred miles from the centre, according to the magnitude of the cyclone, the tempest is terrific. An able navigator once assured me that, being involved in a cyclone, and standing not far from one of the masts of his own ship, the mast was carried overboard without a sound of the falling timber being heard, to give him the least warning of the occurrence, amidst the uproar of the storm. The height or thickness of the revolving disc of air, Redfield informs us, is not greater than one mile, above which the clouds and the wind follow their ordinary course. The diameter of the storm disc, on the other hand, varies considerably, depending in many cases upon the locality of the storm.

The hurricanes of the West Indies vary from 100 miles at their commencement, to 1000 miles in diameter where they spread themselves out over the Atlantic Ocean. The Mauritius cyclones have a width of 150 to 600 miles, in the whole of which the wind blows an excessively severe gale. Those in the Bay of Bengal are 300 to 350 miles in diameter, contracting, however, occasionally to 150 miles, or even dividing themselves into two or more smaller cyclones, pursuing different paths.

The cyclones of the Arabian Sea, and the typhoons of the China Sea, are the smallest of the intertropical hurricanes, being from 60 to 240 miles across, but they are by no means

less terrible than the rest. The typhoon which happened at Hong Kong in July of the present year is one among many instances of their severity.

A few examples of the force of the wind in cyclones will serve as illustrations to the general theory of the mode of action and origin of these revolving storms.

Three hurricanes followed each other in succession over the islands of the West Indies in a single month, the month of October, in the year 1780. The first of these, on the 3rd of October, destroyed the town of Savanna La Mar, in Jamaica, by an inundation of the sea; the second, and by far the greatest of the three, on the night of the 10th-11th, swept over the Island of Barbadoes; the third disabled the Spanish fleet under Solano, in the Gulf of Mexico, on the 20th of the same month and year. The greatest of the three, known as the "Great Hurricane," passed over Barbadoes on the night of the 10th-11th of October, with a violence universally compared to that of an earthquake-shock. The strongest buildings on the island were rent to their foundations; and even the arsenals were destroyed. The spray of the sea, raised twenty-five feet above its ordinary level, was driven by the wind with so much force, as to lift a twelve-pounder gun with its carriage, more than a hundred yards from their places on the bastions. In the midst of this confusion, 3000 persons lost their lives.

On the 10th of August, 1831, another great hurricane visited Barbadoes, in which the sea at St. Vincent rose twelve feet above its ordinary level. At the north point of Barbadoes, the sea continually broke over the cliff, a height of more than seventy feet; and a salt rain fell upon the whole island, by which the waters were rendered unpalatable, and fishes in the ponds were killed. This is also related to have occurred at Mauritius, in the hurricane of February and March, 1818; and again, in a typhoon at Manilla, on the 23rd of October, 1831, the "paddy-fields" of standing rice were turned white by the salt water, which the wind conveyed to them in showers. This effect of the transporting power of the wind was noticed by Robert Stephenson in the construction of the Barra light-house. The water was turned brackish by a storm on the 16th of April, 1838, at a height of 600 feet above the level of the sea. Instances of a rain of salt-water are recorded in the *Philosophical Transactions* in the accounts of the "Great Storm" of the 26th of November, 1703.

The curious circumstance that more rain is collected at the surface of the ground than at a height of only a few feet above it, is perhaps explicable on this principle; for the spray of falling rain is carried upwards by the wind, and becoming attached to the falling drops, increases their size, and is

received in the funnel of the rain-guage, which therefore collects both spray and rain. It is observed, apparently in support of this explanation, that drops of water which fall down the shafts of deep mines gradually increase in size as they descend, until they reach the bottom of the shaft. This is probably owing to spray from other broken drops attaching itself to the drops as they descend.

To return, however, from this digression, suggested by the power of the wind upon the sea, a few instances of great inundations in a cyclone may be noticed here, as illustrating still further the force of the wind. The low-lying plains of Bengal, defended by dykes like those of Holland from sudden incursions of the sea, are frequently exposed to the attacks of the storm-waves of cyclones. Calamities on this coast are frequent, chiefly from the destruction or insufficiency of the dykes. Burrisal, at the mouth of the Ganges, was thus overwhelmed in the month of June, 1822; Balasore, at the mouth of the Hooghly, in October, 1831; and, again, Balasore and Hidgelee were completely destroyed, on the 21st of May, 1833, by a storm-wave which rose twelve feet above the ordinary level of the tide. Calcutta, on the 5th of October, 1864, suffered in its turn. The centre of a cyclone passed that day directly up the Hooghly, and caused an inundation, as well as ravages upon its banks, more fearful than any previously recorded in the history of this kind of storm.

The storm-wave, raised by the force of the wind upon a lee-shore, is in the open ocean impelled in all directions from the centre of a cyclone, and is felt at a distance of even 1000 miles as a swell upon the sea. A surf breaks upon the reefs, and a swell rises one or two feet at the Bermudas, at the passage of every West Indian hurricane near its coast. This disturbed appearance of the sea is accordingly a useful indication of the neighbourhood of a revolving storm, either approaching, or receding, or traversing the ocean, at a distance.

It is important to notice that a depression of the barometer invariably accompanies the passage of the centre of a cyclone. Sir William Reid notices an instance of a typhoon, which traversed Macao on the 5th of August, 1835; in which the barometer fell a full inch and a half at the passage of the centre; while at Canton, not quite sixty miles north from the track of the storm's centre, the oscillation of the mercury was little more than three-tenths of an inch. A number of similar cases are brought forward by Piddington, who distinguishes two classes of cyclones. In one of these, or storms of gentle depression, the mercury descends one or two tenths of an inch an hour, until the centre is near, when it remains almost

stationary, and about an equal time after the passage of the centre it gradually ascends. In the other, or storms of great depression, a further rapid fall of three to seven tenths of an inch an hour takes place in the mercury when the centre is near, or within three hours; and the mercury sometimes reaches its lowest point a little before the passage of the centre. It also immediately rises again as rapidly as it fell. The lowest depression of the mercury in a barometer yet experienced in a cyclone took place on board the "Duke of York," in the storm already noticed, at Hidgelee, on the 21st of May, 1833, when the mercury disappeared in the tube, behind the graduated scale of the instrument, at twenty-six and a half inches, having fallen two and a half inches in the preceding three hours, and remained invisible for half an hour. The oil in the sympiesometer at the same time retired completely, when the mercury in the barometer disappeared, and rose again a little before its reappearance.

Another point on which there is nothing approaching to a doubt in all the numerous investigations that have been made, is the general law of rotation of cyclones. This, in the northern hemisphere, is against the hands of a watch; and a seaman steering down the wind in the northern hemisphere has the centre on his left. In the southern hemisphere the case is reversed; the direction of rotation is the same as that of the hands of a watch; and a seaman steering down the wind has the centre of the storm on his right hand. In both cases the shift of the wind is in the same direction as the shift of the centre of the storm. By attending to these simple rules, ships not only avoid the danger of falling into the centre of a storm, but take advantage of its most favourable semicircles to continue their voyages with a prosperous wind, or even to accompany a storm upon its track.

The general law of rotation of cyclones may also be stated briefly thus:—In both hemispheres it is against the apparent motion of the sun; or, in both hemispheres it is the same as the real direction of the earth's daily rotation. The uniformity of this simple law, Dové has shown, is the result of a law equally uniform and simple—namely, the daily revolution of the earth upon its axis. For the purpose of illustration, a well-chosen example will serve, better than many diagrams, to make this clear. Suppose, for example, that an extensive depression of the barometer, arising from any cause, should take place exactly at the north or south poles of the earth. Were then the earth at rest, currents of air would stream inwards in straight lines from all sides to supply the void. But as the earth rotates about its axis once in twenty-four hours, and with it its atmospheric covering, the air;

this also revolves about the poles. Air, therefore, drawn inwards from the circumference towards the poles (where there is no motion of rotation) must, on arriving there, produce a whirl, or vortex, revolving in the same direction as the earth. Every particle of air, in its approach towards the centre of the whirl, is, moreover, obliged to obey a certain dynamical law, called the law of "conservation of areas," which requires that equal areas in equal times should be described about the centre. In this manner its rotation is enormously increased near the centre of the whirl, and a true cyclone would be produced, revolving in the same direction as the earth, or in that direction which is actually observed.

Each pole is the most central point of the hemisphere to which it belongs. The instance taken as an example is, therefore, a leading, and at the same time a typical, case of what would occur generally at any point of the earth's surface situated between the poles. A considerable depression of the barometer over any region of the earth's surface, arising from any cause, is accordingly sufficient to produce a true cyclone, or eddy of the wind, revolving in the same direction as the earth, or in the direction indicated by the "law of storms," and blowing with the greatest swiftness near the centre of the whirl.

At the equator, where both hemispheres unite, the tendency of the wind to rotate is in two opposite directions; that counteract each other; and, as far as observations at present extend, cyclones exactly on the equator are not known.

Two instances, both of them in the southern hemisphere, have occurred to verify in that hemisphere the correctness of the "law of storms." The first of these crucial instances, as they may be called, and perhaps the most striking, is the case of the "Charles Heddle," which sailed from Mauritius on the 19th of February, 1845, and proceeding northwards, on the 23rd encountered a cyclone. The ship scudded, or, in nautical language, was "put before the wind." From hour to hour, for five successive days, while the vessel drove directly before the wind, the courses steered and the distances run over were regularly entered in the ship's log. In this time, the "Charles Heddle" five times circumnavigated the centre of the cyclone, performing each revolution in the same direction as the hands of a watch, and at the same time was carried, with the centre of the storm, 400 miles back again to the Mauritius, whence she started.

The second instance, not less interesting than the last—if its very recent occurrence is considered—is the case of the vessel, "Earl Dalhousie," bound for Mauritius, which entered a cyclone in the "storm-tract," on the evening of the 14th of May, 1863. The "Earl Dalhousie" overtook and entered the

cyclone's south-east side from north-east. The vessel scudded, and was driven before the wind three times round the centre of the cyclone, while the courses steered and the distances run over, as before, were hourly entered in the ship's log. The first turn of 126 miles was performed in twelve hours; the second, of 85 miles, in eight hours; and between the second and third turns the "Earl Dalhousie" emerged from the storm into the calm centre of the cyclone, where the sky was almost clear, and the barometer fell three-quarters of an inch. The spiral incurving of the wind in this case is indicated by the narrowing circles of the ship's track. Birds and insects, in fact, are thus driven inwards towards the centre of a cyclone. Immediately on entering into the storm, the masts and yards of the "Earl Dalhousie" were thus crowded with exhausted dragon-flies. A peculiar red colour of the sky, often remarked in cyclones, was also observed, the deep purple rays of the setting sun giving the clouds a very wild appearance while the ship approached the outskirts of the storm.

In high latitudes, revolving storms occur at Cape Horn, the Cape of Good Hope, the Gulf of St. Lawrence, and on the western coasts of Europe. The severe gale at the Cape of Good Hope on the 17th of May, and another at Monte Video in August, during the present year, were probably revolving storms, proceeding on their usual course from west towards the east. On the coast of North America, as already stated, the tracks of many storms have been assigned. These issue from the centre of the continent, on straight-line tracks, across the great American Lakes and the Gulf of St. Lawrence towards the North Atlantic Ocean. They spread themselves so far, that one near Nova Scotia, on the 16th of December, 1839, is said to have reversed the trade winds on the Bahamas a thousand miles from its centre. Another, which passed over Halifax, in Nova Scotia, early in January, 1828, was followed by tempestuous weather in England, at Plymouth, at an interval of about a week, and is even suspected to have crossed the Atlantic Ocean from America to the British Islands, a distance of more than 2000 miles.

Two companion cyclones, whose centres passed nearly over Ireland, in a south to north direction, on the 26th and 28th of November, 1838, came from another part of the Atlantic. The last of these circular storms, as traced by Mr. Milne in the *Philosophical Transactions*, included the Azores, Madeira, and a large part of western Europe in its whirl. A great part of the contrast of climates between the opposite coasts of Europe and America may be supposed to arise from the existence of such cyclones on the North Atlantic Ocean, as well as from the direction of the regular anti-trade winds. Frequent north-east

gales are thus produced in the Gulf of St. Lawrence, and south-west gales upon the coasts of Europe—occasioned, doubtless, by circular storms that range at large upon the unimpeded surface of the ocean.

Telegraphic storm-warnings to shipmasters were first despatched in the year 1842, from Chicago to Buffalo, across the great American lakes. Similar systems, as already described, have more recently been adopted in almost all countries in Europe, and seaports are thus secured from the dangerous arrival of unexpected storms.

About the close of the year 1859, a collection of meteorological facts, in and around the North Atlantic Ocean, was begun in England and America, such as never could have been accumulated at any former time. In that year, on the 25th of October, a cyclone known as the "Royal Charter Storm" sprang up at the entrance of the English Channel. The storm was of the greatest magnitude and violence, and not less remarkable for its distinctly cyclonic character.

Two ships, the "Alipore" and the "Neikar," one approaching to and the other leaving the English Channel, encountered no cyclone approaching the English Channel from south-west. On board these ships, 28·98 inches was the lowest registered pressure. Its first appearance was near the Eddystone Rock, where the channel fleet at that time was stationed. At three in the afternoon, the centre passed over the fleet, the wind blowing suddenly from opposite directions, with an intervening calm space of about half an hour, during which the barometer fell to 28·50 inches. The focal calm, having thus a diameter of about seven to ten miles, passed from Cornwall, across the centre of England, to the borders of Lincolnshire, in eighteen hours, with a progressive speed of fourteen miles an hour. At sunrise, on the morning of the 26th of October, the centre was advanced not quite so far as Nottingham, and a vast whirlwind, revolving in a direction contrary to the hands of a watch, extended over England. The "Royal Charter" was lost towards seven in the morning, with nearly all on board, on a lee shore on the northern coast of Anglesea. At the same time, the west coast of Ireland, and a large proportion of that island, were not affected at all; and the weather in France continued fine. The greatest diameter of the whirl was therefore little more than 400 miles. In the north-western half of this area, the velocity of the wind cannot have been less than 60, nor in the south-eastern half much less than 100 miles an hour, being increased by the progressive motion of the storm. The storm advanced towards the North Sea, and severely assailed the coasts of Scotland, when a calm state of the atmosphere was already

restored in the English Channel. It then crossed the North Sea, and descended upon the coasts of Norway, where its energy was almost expended on the 27th.

The "Royal Charter Storm" was quickly followed by a companion-cyclone, which extended its ravages across the British Isles on the 1st-2nd of November. On November 1st, this storm's centre crossed Ireland to the north of England, and then, on November 2nd, appeared to diminish rapidly in its strength as it overspread the North Sea, progressing towards Denmark. It appears from the long-continued observations of Mr. Stevenson near Berwick, and of Dr. Lloyd at Dublin, that this track is the most frequent course of British cyclones. They chiefly traverse the northern portions of the British Islands, from south-west towards north-east, from west towards east, or even occasionally from north-west towards south-east.

Communications received at the Paris Observatory from a great number of the chief towns and seaports of Europe, enabled Mr. Marié Davy to anticipate the arrival of a furious gale in England and France, on December 1st-2nd, 1863, as early as the 27th and 28th of November. All the north coasts of France were warned upon the 30th of November. The first to be exposed to the fury of this storm, the British Isles were warned of its approach on December 1st. Rapid communications were effected on the same day along the coasts of France. The centre of the storm was advanced as far as Liverpool on December 2nd, and Cherbourg for the first time experienced the full force of the wind. Telegraphic messages, despatched from Paris on this day, reached Toulon, Genoa, Civita Vecchia, and Palermo, in time to prevent accidents to shipping in the Mediterranean; but no answers to these messages could be returned, as the telegraphic wires were, in many places, broken by the violence of the wind, which raged in France throughout December 2nd. The admirable success of these arrangements could only afterwards be learned through the columns of the public papers. The wind was first felt in its full force at Cherbourg at ten in the morning, at Toulon, near Marseilles, at half-past three, and at Genoa at half-past seven in the evening of the same day. Strasbourg, and other places in France at a considerable distance from the central track, experienced no commotion in the atmosphere until the following day.

The advantage to science arising from the judicious collection of a wide range of meteorological facts by the use of the electric telegraph, is at least as great as the services thus immediately rendered to navigation and to trade. On the charts daily published in the "bulletins" of the Paris Observatory, the barometric lines of equal pressure cross the

Continent of Europe in definite, well-proportioned, and, so to speak, eloquent curves. Nothing, apparently, prevents that the atmosphere should be delineated and mapped down at regular intervals of time, with the same distinctness as the shoals and currents of the sea. The course of European storms is clearly traced, upon these charts, arriving from the North Atlantic Ocean upon the coasts of Ireland and Scotland, and thence passing eastward across the North Sea to the Continent of Europe, where they descend to the Mediterranean Sea, or traverse the continent to the east of Russia. All that remains to be ascertained with regard to these revolving storms is the place and mode of their formation, concerning which it must be confessed that much uncertainty prevails. Perhaps the Atlantic Telegraph Cable, when completed, by connecting Europe with the opposite lip of the great Atlantic basin, will supply us with the missing link. At present, the subject is made one of increasing interest, by Mr. Le Verrier's recently-undertaken study of the meteorology of the North Atlantic Ocean.

PLEASANT WAYS IN SCIENCE.

No. II.—Equilibrium and Repose.

In the first of these papers we considered certain facts belonging to what we designated "Curiosities of Motion." We found that all things change, and that nothing is absolutely still. Let us now consider a few phenomena belonging to conditions of equilibrium and repose. In an absolute sense, no objects can be so described, but very close approximations to these conditions may be found throughout the universe. Equilibrium means a state of equal balance, and we shall arrive at some elementary and serviceable ideas by considering a pair of scales, or, more simply, a well-balanced scale-beam, without the pans. If such a beam be placed in perfectly still air, and away from sources of disturbance, it will remain perfectly level; but if accurately made, the slightest force acting upon either end will produce an oscillation, and, if continuous, a subsidence of the end affected. A feeble current of air, a very small magnetic or electric attraction or repulsion, a gentle heating of one end, with consequent expansion changing the position of the centre of gravity—any of these things will disturb the equilibrium, and cause a state of motion to follow the state of rest.

Now, making a pair of scales may appear a very simple thing, and yet, when a near approach to perfection is required,

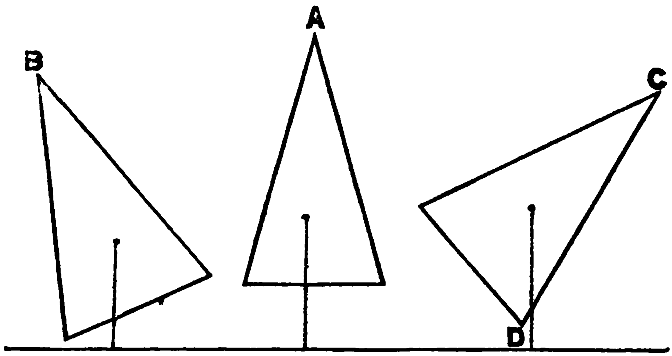
the task is found to be surrounded by a variety of difficulties, requiring considerable skill and science to overcome. To understand this, we must arrive first at a distinct comprehension of what is meant by *centre of gravity*. Terrestrial gravity, or weight, means the mutual attraction exerted between the earth and any given body, as, for example, a piece of wood. Take a strip of wood, or of card, which will do as well, say six inches long, and half an inch wide, run a needle through it near one end, and support the needle on a couple of wine-glasses, so that the card can fall between them. The long end of the card will touch the table on which the glasses stand, and, if lifted up, will immediately fall back again. Why? Because the earth attracts and is attracted by all the particles of the card, and there are more of them in the long end than in the short; that end therefore falls. If the short end is weighted, so as to attract and be attracted by the earth as much as the long end, a balance will be obtained, and neither end will fall. The quantity of weight on either side of the needle which passes through the point of suspension can be adjusted quite as well by moving the needle as by adding to the weight of the lightest end. There must be a point in every solid so situated that exactly as much weight lies on one side of it as on the other. In a regular solid, like a solid square or a solid parallelogram, we can find this point by drawing diameters across opposite corners; they will cross in the centre of the figure, which is also its centre of gravity. In a circle, the centre of the figure is likewise the centre of gravity, presuming always that the object is of equal density throughout. In irregular figures, the centre of gravity is more troublesome to find; but when found, has the same property, that if the object is suspended at that point it can remain at rest. A body acts as if all its weight were concentrated in its centre of gravity; and, consequently, whatever be the mode of its suspension, the centre of gravity will fall as low—that is, as near the centre of the earth—as it can. Now, if a body has a pin run exactly through its centre of gravity, and that pin is strong enough to bear its entire weight, it is obvious that the centre of gravity cannot fall lower than it is already placed. To do so, it would have to break or bend the pin, which we have supposed impossible. If, therefore, we run the needle exactly through the centre of gravity of our piece of card, we shall find that it can be at rest, or balanced in any position. Both arms may be horizontal or vertical, or in any intermediate position; and whatever tendency of weight operates upon one arm in one direction, must operate upon the other arm in exactly an opposite direction, and so both arms will be in equilibrium wherever they are placed.

In these experiments we suspend a body, free to move about the point of suspension, so that it may be at rest in any position; and we see that to do so, we must suspend it by a support passing through its centre of gravity. Let us now suppose we wish to communicate motion to any body, so that all its parts shall be impelled in the same direction, and with uniform velocities; how are we to proceed? Take a billiard ball for an example. If one side of the ball is struck, that side is impelled to move faster than the other; but if the ball is hit exactly in the centre, its tendency is to move straight forward in the direction of the impelling force. Thus we see that, if an object is struck, so that the line of the force acting upon it passes exactly through its centre of gravity, the whole body is impelled to move straight forward with equal velocities affecting all its parts. If struck to the right of its centre of gravity, one side is impelled to move quicker than the other, and consequently the body rotates round its centre of gravity as well as moves forwards, if it is free to do so. The centre of gravity of a body has therefore two noticeable properties—a support passing through it will supend the body, so that its balance is not disturbed by change of position, and a force passing through it•impels the whole body to move equably forward in front of the impelling force.

A body is in a state of equilibrium when the action of gravitation does not tend to alter its position; but there are three distinct kinds of equilibrium—*stable*, *unstable*, and *neutral*. Stable equilibrium indicates a decided preference for a particular position of equilibrium. This is the case when a cone is allowed to stand on its base. If you lift the base up a little on one side, it falls back to its previous position; and in order to make it fall over, you must lift one side of the base so much, that a perpendicular from the cone's centre of gravity shall fall beyond the base, and then it will fall over on its side. Any body in stable equilibrium has its centre of gravity so far from the edge of its base, that if thrown slightly, or even considerably, out of position, it tends to fall back to where it was before. A centre of gravity is in its normal position when it has fallen as low—that is, as near the centre of the earth—as it can. If elevated above the lowest point it can reach, and allowed freedom for motion, it will get back to the lowest point by the shortest route. In the annexed diagram, let the three triangles represent three cones. Their centres of gravity will be exactly over the centre of the base, and one quarter of the distance from the vertex to the base above it. In A a perpendicular from the centre of gravity is considerably distant from either edge of the base. In B we see it displaced, but its shortest way of getting to the lowest point is to fall to the

right, so as to bring the cone back to the position shown in A. In C, the nearest way for the centre of gravity to reach its lowest point is by the cone falling on its side towards the right; and it will be seen that a perpendicular from the centre of gravity falls in the same direction to the right of the base and outside it. A body like A is in a stable equilibrium, because a moderate or considerable disturbance leaves it able to recover its position. If C were balanced exactly upon the point D, it would be in unstable equilibrium, because the slightest force would make it fall on either side.

Neutral equilibrium is when a body cannot alter the position of its centre of gravity by any motion it can take. It is thus equally at rest, or in equilibrium, in all its possible positions. A ball resting on a plane is in this condition, because its revolution leaves its centre of gravity at all times exactly as high above the plane as it was before.



To return to our scales: let the piece of card already spoken of represent the beam. If the needle by which it is suspended passes exactly through its centre of gravity, it is in neutral equilibrium, and the two arms balance each other in whichever way they are placed. But if the needle is moved so as to be a little above the centre of gravity, a slight motion of the beam elevating or depressing either arm is resisted by its weight, because any such motion lifts the centre of gravity above its lowest point, to which it will immediately fall back, and at which it will settle after a few oscillations. If the needle is again moved, so that it is placed considerably below the centre of gravity, the slightest force will throw the beam on either side, and it will not oscillate, but remain fixed as soon as the centre of gravity has reached its lowest point.

This sort of explanation is dry to read, but may readily be made interesting by the performance of the experiments described. In making scales, two things have specially to be

considered—firstly, the elimination of friction, so that the least possible obstacle of that kind may hinder the free motion of the beam; and, secondly, the arrangement of the point of suspension above the centre of gravity, so that the beam may be in stable equilibrium, to the extent of always desiring to return to one and the same position, but with this tendency sufficiently weak as to be counteracted by a slight force. The exact distance between the centre of gravity and the point of suspension must be determined by the use to which the scales are to be put—the greatest delicacy and freedom of motion being required for the most precious articles, and the most accurate weighing.

It seems a sudden jump from a pair of scales to a percussion cap, but yet the transition is easy. A good pair of scales are just within the conditions of stable equilibrium, and a percussion cap contains a substance—fulminate of mercury—which is just outside those conditions. Chemical forces are capable of balancing each other as mechanical forces do. The balance may be upset with difficulty, and then the body belongs to the class of stable compounds, such as all ordinary earths and stones; or it may be upsettable with facility, and then the body belongs to the class of unstable compounds, of which fulminate of mercury is one, and which we find is decomposed by a smart blow. Some bodies of this latter kind, such as chloride of nitrogen, explode violently on mere contact with most other substances.

A body may be in the state of rest called equilibrium, and yet be far from actual and absolute repose. Thus a scale beam, equally heated throughout its length, is in active internal motion; but as both arms are lengthened at the same time, and in the same proportion, the equilibrium of gravity is not disturbed. Astronomy furnishes remarkable instances of groups of balanced motions producing the equilibrium of systems, every part of which moves in harmony with the rest. Astronomy also brings before us the conception of compensated disturbances, or aberrations, an arrangement which permits certain departures from the main plan, in such a manner as to consist with the stability of the whole. If we descend from great things to small, and pass from Nature's grand clockwork in the starry orbs to man's little clockwork with his chronometers, we find analogies in the mode of operation; and that form of pendulum, in which the expansion and consequent lengthening of the pendulum-rod is counteracted by the expansion and rise of mercury in the glass vessel which constitutes the pendulum-bob, illustrates to some extent the mutually compensating irregularities by which the true relation between suns and planets is maintained.

It is by establishing the kind of equilibrium we have described that bodies are preserved as *wholes*, notwithstanding the motion of their parts, or the change of their constituent atoms. The inorganic world affords us continual instances of the first of these actions, and the organic world of the second. In the latter there is an approximate equilibrium of waste and supply. The two processes are seldom equal. When the supply predominates in a healthy individual, growth is obtained; and when the waste predominates, dissolution ensues.

The social world has its equilibriums, stable and unstable, like the physical and the chemical worlds. In societies in which rights are respected and duties performed, the stable equilibrium is attained; and if disturbance ensues, and the fabric shakes under hostile assaults, it may still regain its condition of individual activity and collective repose; while in other societies in which injustice is the predominant force, the resulting equilibrium of despotism is unstable, and when a shock comes the

"Castles topple on their warders' heads."

It has been well said that "harmonious motion is divine repose." Absolute rest, with its negations, so appalling to the European mind, constitutes the highest felicity of the Buddhist; but in a healthy human being, a higher kind of rest is achieved in the compensating movements and harmonious working of divers faculties. The muscular system relieves the nervous, the nervous excites the muscular; the affections not only stimulate the intellect, but they relieve its labours; and by a grateful alternation of different modes of action, life's varied functions are performed in due season, so that to exist is to enjoy.

ON THE SPECTRA OF PIGMENTS.

BY HENRY J. SLACK, F.G.S.,

Member of the Council of the Microscopical Society of London.

When light reaches us by reflection from a coloured object illuminated by white light, the effect upon our eye results from the rays which remain in the spectrum after the object has removed by absorption other rays which are complementary to its own colour, and which would make white light if added to that colour. In like manner, coloured transparent or translucent bodies, on which white light falls, absorb certain rays and transmit others—those which they absorb and those which they transmit being together equal to white light. If therefore we view through a spectroscope that portion of white light which is transmitted or reflected by a coloured object, the character of the spectrum will indicate the exact nature of the absorption that has occurred.

The application of the spectroscope to the microscope just made, in a new pattern, by Mr. Browning, and figured in the last number of the Intellectual Observer, is exceedingly convenient for such experiments, and I have made several, both with flowers and pigments. It is the latter only that will now be described. The most interesting pigment spectrum I have as yet seen is that of cobalt. A little patch of the water-colour paint so named is laid in flat tint on a piece of white paper, illuminated by a bull's-eye, lieberkuhn, or side reflector, and viewed through the micro-spectroscope, when two bands are seen in the green, much like those of the blood spectrum, and a third line in the red. An inch or two-thirds is a convenient power for these experiments; and it will be remarked that, in the cobalt spectrum, the bands in the green look green, and that in the red looks red, both being of darker tint. If a minute spot of blood is placed upon a piece of white paper, and a spot of cobalt immediately above or below it, both will come into the field at once, with an inch or two-thirds, and the resemblances or differences between the two spectra can be conveniently observed.

It is interesting to compare the spectrum of ultra-marine with that of cobalt. With care, a cloudiness is seen affecting the green somewhat unequally, but no distinct band in the spectrum of the former pigment.

When a little patch of vermillion is seen through the micro-spectroscope, the purple is stopped out, and the green converted into a dark greenish grey.

Emerald green affords a spectrum from which the purple is excluded, while a delicate shade overspreads the green. A dark shade is seen in the least refrangible red, and a lighter shade in the rest of the red and yellow.

Yellow ochre, purple, and blue shut out, dark shade in green nearest the blue.

Rose madder, shadow in purple and blue, band in green.

By pursuing these experiments with a variety of coloured objects, an insight will be gained into Nature's method of painting, and some curious optical facts may be ascertained. When water-colour paints are laid on white paper, if transparent, they allow a certain portion of white light to be reflected from the paper; and if opaque, it will generally be found that certain roughnesses in the paper have remained comparatively unaffected by the pigment. More white light will also be reflected at certain angles than at others. Allowance must be made for these facts; and with some colours the experiments may be conveniently varied by transmitting a bright pencil of light through the paper on which they are placed, and contrasting the effects of transmitted and reflected light.

Having tried the spectrum of cobalt as a water-colour pigment, take a piece of the blue glass with a violet tint commonly used in decoration, and said to be coloured with cobalt; this gives a fine spectrum with transmitted light. On trying a piece rather more than 1—16" thick, a broad dark band was seen at the edge of the red and yellow, next to which was a band of dingy red, only visible under strong illumination, occupying part of the place of the yellow, then an apple green space, and then a dark green band, with a paler green space leading to the blue. Another piece of blue glass, rather thinner and with less of the violet tinge, gave a similar spectrum, with some slight though interesting differences. The dark tint between the two bands in the red and yellow was paler, and less opaque. Experiments should be tried with various tints of smalt glass, of different thicknesses.

THE FLINT TOOLS OF NORTH DEVON.

BY TOWNSHEND M. HALL, F.G.S.

(*With Two Plates.*)

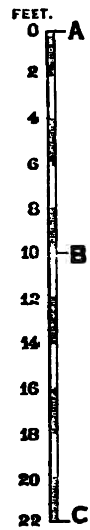
No field of investigation so completely acts as a connecting link between the geologist and antiquary as that which within the last few years has excited such an unusual amount of interest, and has been the ground of much dispute—the records of Præhistoric man as read by the light of the flint implements from the "Drift." The question stands now as it has stood for some time past. Flints of a certain shape are found in the drift, a deposit considered by geologists to be of an antiquity so vast, that no scale of time can be correctly applied to measure its age. If therefore the flints received their shape from the hands of man, then the human race must have existed at the time of the formation of the drift-beds, and must be of an antiquity equally great. Although this reasoning may be perfect in a logical point of view, still for practical purposes and for practical inquirers it may be somewhat too inductive in its character. Two important questions arise at the very first stage of the subject. First, are the flints really shaped by the hands of man, or is their peculiar form of cleavage produced by natural causes of fracture? Secondly, is the drift of the extreme antiquity geologists have assigned to it? With regard to the first, the flints which have been found can all, or nearly all, be classed according to their shape, and reduced to three or four definite patterns or standards. Natural causes of fracture will no doubt, on very rare occasions, split flints into a somewhat approximate form, but it would be stretching the bounds of the laws of probabilities to too great an extent to suppose that all, or even a fractional part of the number of shaped flints found at different times in France and elsewhere, could have received their form by natural sources of fracture. Of course some natural process, of which we are now ignorant, may at one time have been in operation; but if in the valley of the Somme, in the Dordogne, and in two or three places in England, it turned so many flints into hatchets and arrow-heads, how is it we do not find abundance of these arrow-heads and hatchet-shaped flints in Hampshire, Wiltshire, Dorsetshire, and every other county where the raw material is so plentiful, and where therefore the "natural process" would have full scope for development? Other evidence bearing on the question of art *versus* nature is to be found in a bulbous projection which may generally be noticed on the flat side of the flake. It always points out the spot where the

blow was administered to strike it off from the mass; corresponding depressions may be seen on the other facets of the flake, thus showing that it is the result, not of one chance blow, but of at least three or four successive blows, each administered in the proper place, and consequently it must have been the work of an intelligent being.*

Secondly, are the drift-beds of the immense age assigned to them by geologists? In the valley of the Somme, for example, where they are considered by the highest authorities to be of fluviatile origin, was the detritus necessary for their formation brought down by the rivers, torrents, and glaciers of old, at a uniform rate, one year after another? for if the accumulating force was irregular or intermittent in its action, then measurements and calculations of thickness in feet and inches can afford us no very satisfactory criterion of age. A lake will soon form in a valley, especially if the surrounding district is uninhabited, or peopled by a race of savages. A tree will fall across the stream, this will cause others brought down by the torrent to accumulate on the same spot, and by degrees an embankment of considerable height will arise to restrain the flow of the river, and form a lake. But after a time either the increasing pressure of the pent-up water, or the decay of some material composing the bank, will cause the barrier to burst, and not only will the accumulated matter be brought down by the flood, but for miles it will sweep away every obstruction, scoop out the river-bed, and form, when its violence is expended, a thick bed of *débris*, which will spread over the whole width of the valley, and be almost uniform in its thickness. Thus although from the general conformation of the ground it is improbable that such a lake ever existed in the immediate neighbourhood of Abbeville or Amiens, where the valley of the Somme is little less than a mile in width, still if a cataclysm of this nature took place farther up, in the contracted part of the valley, it would not only account in part for the low-level drift, but also for the fact that the "tools" are found at such an unequal depth below the surface. Thus they are sometimes met with at a depth of 30 feet. One mentioned by Sir C. Lyell in his address to the British Association at Aberdeen in 1859, was found in the pit of St. Acheul, near Amiens, at a depth of 10 feet. Mr. Evans, too, in his paper to the Society of Antiquaries, read June 2, 1859, states that in the same pit he saw one *in situ*, 11 feet from the surface. Another, found by him at Hoxne in Suffolk, lay at a depth of 8 feet, and some from Long Low, Wetton, are described in the same paper as occurring "near the surface;"

* See *Archæologia*, vol. xxxix., p. 76.

"a circumstance," adds Mr. Evans, "which in no way affects the question of their antiquity." * Taking for our data the two weapons we have first named, found at St. Acheul, at a depth of 10 and 11 feet respectively, and contrasting them with two others found in the very same pit, the one at a depth of 20 feet below the surface, and the other discovered by Mr. Flower lying *in situ* at a depth of 22 feet,† let us for the sake of simplicity make use of a diagram, and put A to represent the present time, A.D. 1865, B the minimum (10 feet), and C the maximum depth (22 feet), at which weapons have been found. It will then be perfectly clear that if the drift has accumulated at a uniform rate per annum, man must have existed at Amiens during a period so long that the difference in age between B and C is considerably more than equal to the number of years which must have elapsed between B and A; and can we conceive it possible that during this long, long time any race of man, however savage, could go on generation after generation continually fashioning the same old shape of knives, arrow-heads, and hatchets out of flint without the slightest improvement, and leaving us not even a fragment of pottery to attest their progress in the arts?

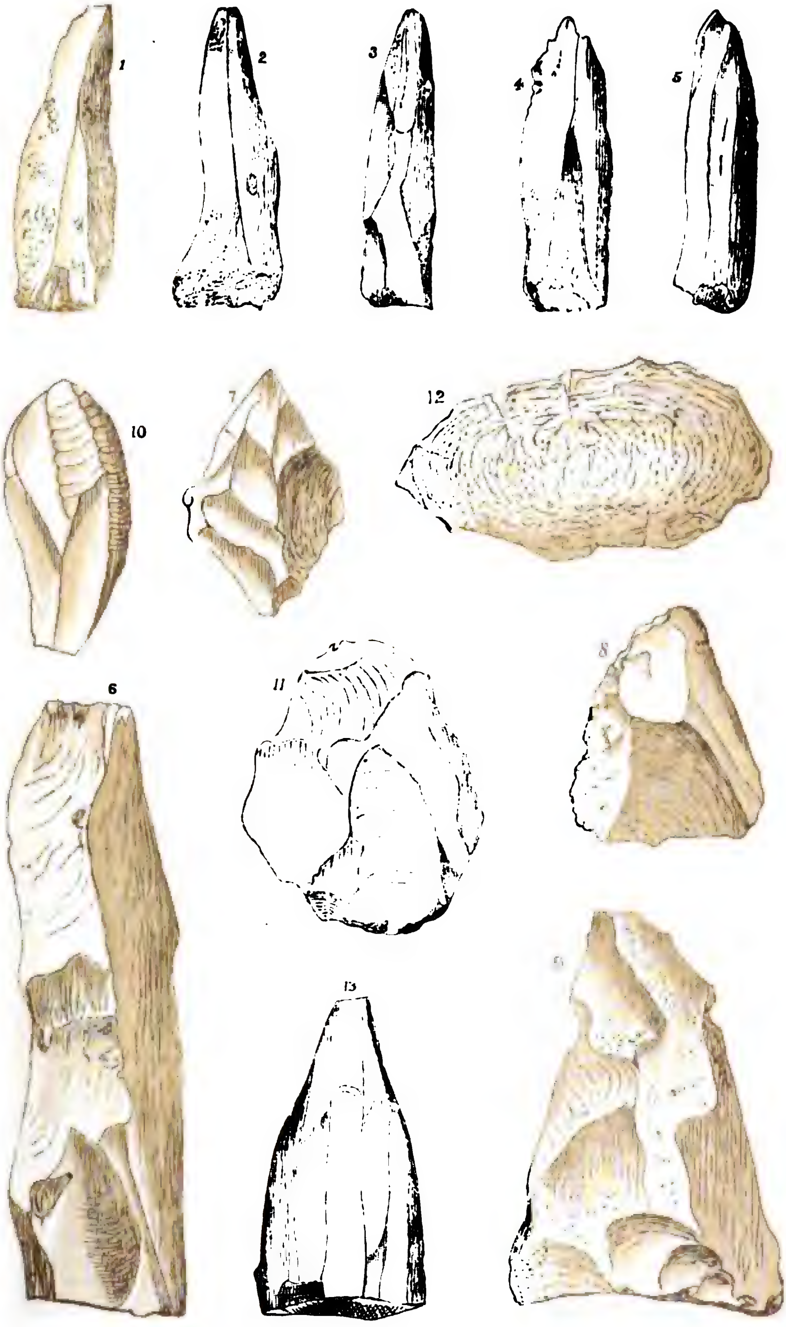


In this brief sketch of the records of Præhistoric man, I have purposely left untouched the evidence of the bones of extinct mammals, which in many places are found associated with the implements, because remains of the same species of mammals have been found in caves in juxtaposition with man's bones and articles of man's workmanship—found side by side with flint flakes, combs, pins, armlets, rings of bronze and iron, and coins of the Roman Emperors from Nero to Constantine,‡ therefore it must be admitted they cannot serve as infallible data to prove or disprove the antiquity of man and the age of the drift.

Passing from France to England we find flint implements in the drift at Hoxne in Suffolk; near Herne Bay, at Bedford, and two or three other places. This article, however, is headed with the name of North Devon, and so to that district and its records of primeval man I must proceed without any further delay.

Baggy Point, the bold and rugged promontory bounding Barnstaple Bay on the north side, and distant from that town

* *Archæologia*, vol. xxviii. p. 302. † *Antiquity of Man*, p. 103.
‡ *Geologist*, vol. iv. pp. 539—295.



T. M. Hall, F.G.S., delt.

FLINT IMPLEMENTS FROM NORTH [illegible]

ten miles, is well known to geologists from the raised beach which extends for a considerable distance along its coast, at a height of nearly 40 feet above the present level of the sea. It has been described by Sir H. de la Beche, and has at different times formed the subject for two or three papers to the Geological Society. Drift beds 16 feet thick occur in several places, mixed up with the raised beach; but as both formations are at the same level, and of nearly the same thickness, they are never visible together to their full extent in any one section, one always takes the place of the other, either altogether or in part. In one place where the raised beach is entirely wanting, and the drift occurs at its full thickness, I have found lying immediately on top of it, rude flint implements in great numbers, associated with calcined flints, rough sun-dried pottery, and a chipped stone hatchet. The majority of the "tools" are only flakes, or futile attempts to produce three definite forms, amongst which knives and arrow-heads appear to be the favourite shapes; and although the flint employed must have come from a considerable distance, chippings of the material are associated in such profusion with the tools as to imply that there must formerly have been a manufactory of implements on the spot. They are covered with from 3 to 3½ feet of compact and undisturbed alluvial soil, of which the six or eight inches next the drift, and enclosing by far the largest proportion of flints, is a layer of black earth, forming a great contrast to the reddish colour of the ordinary soil. One peculiarity of their geographical situation must not be left unnoticed. They are found near the mouth of a transverse valley, where there is a small flat space about 200 yards square, sheltered completely from the north by a range of hills, and more or less also from the east and west. A small stream of fresh water flows down the bottom of the ravine, all conducing to render the spot suitable in the estimation of savages for the site of an encampment. Over most of this flat area flakes (many of them carefully chipped) appear to be scattered, but in some places they occur much more abundantly than in others. Amongst the large quantity of these flints found at different times by myself in this one locality, there is a great gradation, not only in the size, but in the form of those which must be included under the name of "arrow-heads and knives." A reference to the accompanying Plates will show that many of the tools bear unmistakable signs of having been chipped into shape with the greatest care, and those of our readers who are acquainted with the unrivalled collection of M. Boucher de Perthes, at Abbeville, and the new Amiens Museum, will recognize the close affinity between the "tools" from Baggy Point and some of the

smaller implements from the valley of the Somme, although none of the large hatchets, so abundant in France, have as yet been discovered in North Devon. Some also are analogous in form to the ruder weapons found by M. Lartet and the late Mr. Christy, in the caves of the Dordogne, others are clearly the cores from which the thin knife-like flakes have been struck. The chief number, however, are chippings, and the larger fragments, although they show traces of design on the part of the maker, have been rejected as utter failures to produce anything serviceable, either for domestic use or for purposes of war. Some few are mere pieces of flint knocked off, apparently, in the very earliest stage of the manufacture, showing on one side the conchoidal fracture, and on the other the original external coating, or crust, of the nodule.

After many excavations, numbering altogether ten or eleven, since August, 1863, I lately determined to make one on a more extensive scale, in order to ascertain exactly the relative proportion which the arrow-heads and knives bear to the failures, and therefore, on the 19th of July last, took advantage of the kind offer of a gentleman staying in the neighbourhood to supply me with two or three men, so as to make a thorough examination of the spot which appeared most fruitful in tools. A pit was dug through the alluvium down to the drift. Its length was 12 feet, and the width at the narrowest end 7 feet, while at the south end it widened to 14 feet. All the earth was thrown up for me to examine, and the result of a careful search (I may say sifting) was the discovery of 366 flints, counting fragments of all sorts, shapes, and sizes, which, on my return home, I classed under the following heads. The first column of figures gives the actual number of specimens of each type, and the second the proportion that number bears to a thousand. The latter will consequently be found the most convenient for purposes of general reference, as from it the exact percentage can so readily be obtained.

Flint flakes shaped carefully by chipping, they all approximate in form to one of three types (see Plates), and are imperfect only as regards deficiency in point	72	196
Ditto, badly shaped and imperfect	60	162
*Attempts of the rudest description . . .	114	316
Cores, generally of large size, from off which flakes have been struck.	53	144

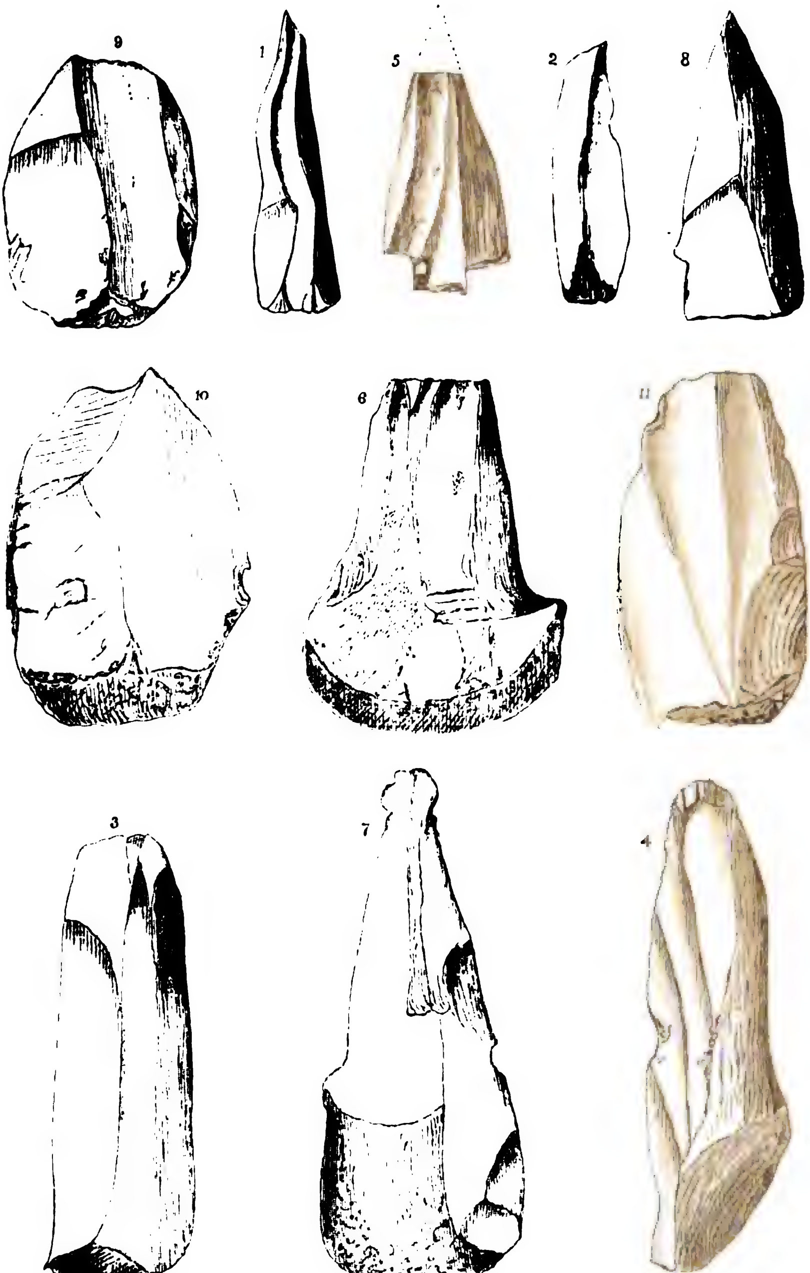
* Among the attempts and failures I have counted many which were accidentally broken by the workmen.

[illegible] from the valley of the S[illegible], [illegible] so abundant in France, have [illegible] Devon. Some also are analogous [illegible] found by M. Lartet and the late [illegible] of the Dordogne, others are [illegible] knife-like flakes have [illegible] are [illegible], [illegible] traces of design [illegible] as other features [illegible] domestic [illegible] pieces of flint [illegible] of the manufacture, [illegible] of the middle.

[illegible] together ten or eleven [illegible] took advantage of the [illegible] road to [illegible] a thorough examination [illegible] most fruitful in tools. A pit [illegible] to the drift. Its length [illegible] end 7 feet [illegible] to 14 [illegible]. All the earth was [illegible] was [illegible] of flints, containing fragments [illegible] which, on my return [illegible] the first column [illegible] of specimens of each type, and [illegible] are to a [illegible] the most [illegible] exact percentage [illegible]

[illegible] they [illegible] one of three [illegible] only [illegible]		
[illegible]	72	1[illegible]
P[illegible] perfect	[illegible]	1[illegible]2
* [illegible]	111	2[illegible]
C[illegible] from which		
[illegible]	[illegible]	141

* Among [illegible] I have [illegible] which were [illegible] taken by the [illegible].



T. M. Hall, F.G.S., delt.

FLINT IMPLEMENTS FROM NORTH DEVON.

Fragments of flint, showing conchoidal fracture on one side, and the external coating or crust of the nodule on the other . . .	34	92
Calcined cores and flakes	30	81
Whole flint nodules	3	9
Total	366	1000

Let us now analyse the facts of the case. In the first place, flint is not found naturally in that part of North Devon, as there is no chalk nearer than seventy miles, and green sand with flint occurs only in two fields at Orleigh Court, in the parish of Buckland Brewer, distant from Baggy Point thirteen miles in a direct line, of which four are across a portion of Barnstaple Bay. Supposing, then, a manufactory of weapons existed at Baggy, it is evident that the raw material necessary for the formation of the tools must have been brought either by sea or land a considerable distance for that express purpose.

Secondly, the presence of calcined flint is of great importance as a proof of human handiwork. Everybody knows that flint splits naturally with what mineralogists term a conchoidal, or shell-like fracture—in fact, the same kind of fracture that may be seen in broken bottle glass, or in obsidian; but flint, as soon as it is subjected to the action of fire, immediately loses the conchoidal, and assumes a hackly fracture, when it becomes perfectly impossible to split or chip it into any shape or form. Many out of the thirty calcined flints have flat surfaces and facets, showing a conchoidal fracture; and this circumstance, therefore, affords conclusive evidence that their shape was received by splitting and chipping, *before* they were subjected to the action of fire.*

Lastly, the evidence of the pottery and stone weapon. The former consists of three fragments, just sufficient to identify as having originally belonged to an urn, or some vessel of similar shape, which, when perfect, must have been 8½ inches in diameter. One of the portions contains a small projection, evidently intended to serve as a handle. Bits of quartz have been worked up with the clay, so as to give it greater consistency. It is fashioned rudely by the hand, sun-baked, and totally destitute of any attempt at ornamentation.

With regard to the artificial character of the stone "hatchet," I can speak less positively. It is made of very hard sandstone, and certainly bears the appearance of rough chipping, whilst one side shows traces of the action of fire. Still, as this

* So completely is the texture of the flint altered by the calcination it has undergone, that small cracks or fissures traverse the flakes from one side to the other, and its specific gravity is reduced from 2·54 to 2·4.

"tool" is the only one of its kind found in that locality, it may possibly be only a stone selected from the neighbouring beach, with the view to turning its peculiar shape to account, for the purpose of a weapon, and therefore, with such uncertain data, I am unwilling to speak too definitely on the subject. Thus much for the evidence of art; but proofs of antiquity are not wanting, for, apart from the fact that the flints are covered with nearly four feet of undisturbed soil, in a desolate and almost uninhabited part of North Devon, there is another and surer proof in the patina, or varnish-like film which covers most of the flakes. It is produced by a very slow and long-continued chemical action, and may be regarded as a good, though not universal sign of great antiquity. Indeed, the only occasion on which it appears to fail, is when the flint partakes largely of the nature of agate or chalcedony.

Thus it will be seen, on carefully comparing the flint tools of North Devon with those of the first or Drift period, that they differ materially in two points only. They are found immediately on top of the drift, instead of in it, and they occur in juxtaposition with certain proofs of their human origin, whilst, at the same time (although on the average much smaller), they are as rude in design and manufacture as any of those from Amiens or Abbeville.

They differ, on the other hand, from those of the second, or Celtic period, by being split and chipped into form, instead of having their points and edges shaped by the more civilized process of grinding.

To which class, then, must the tools of North Devon be referred? Are they to be put amongst the implements of the first period, because they are chipped, and not ground; or are they to be ascribed to some early tribe of Celts, on account of the associated pottery? Or may they not, rather, form a connecting link in the scale of progression between the two? That there must have been such connecting links is obvious, otherwise how could the Celts have followed so closely in the steps of the men of the "Drift," making the same shaped tools, but making them look better, by a long and tedious process of grinding. With the ground and polished tools of the second period are found pottery and various articles, indicating a considerable advance in knowledge and intellect. Did man, then, make this progress at a sudden bound? Did he suddenly discard all weapons made in the old style by chipping and splitting, and use none but those which involved the expenditure of much labour on the part of the maker, and, after all, made but a poor substitute for the knife-like edge of a split flint? Or is it not more probable that this progress was the result of a gradual development of intellect; and that,

if the axiom of Bacon is true of nature—"*Nihil facit per saltum*"—it is true also of the progress of Præhistoric man? The drift and alluvium of Europe has, comparatively speaking, been but little explored; and no doubt new discoveries, or further investigations into some of those which have been made already, will throw more light on a subject interesting alike to the geologist and antiquary, the ethnologist and divine.

Plates I. and II. represent flint flakes from Baggy Point, drawn (full size) from specimens in my collection. The reader may see at a glance that they resolve themselves into three distinct forms or types, although between these forms there are numerous gradations, caused by the uncertain character of the material of which they are made.

REFERENCES TO THE PLATES.

Plate I., Figs. 1—6; and Plate II., Figs. 1—4.—Tools of the first type. Flakes or knives usually of the same width near the top, as they are at the bottom.

Plate I., Figs. 7—9; and Plate II., Figs. 5—8.—Second type. Arrow-head shaped weapons, which sharpen to a point more or less gradually from their base.

Plate I., Figs. 10—11; and Plate II., Figs. 9—11.—Third type. Oval implements with a cutting edge all round, or nearly so.

Plate I., Fig. 12.—The flat side of a calcined flake.

Plate I., Fig. 13.—Small core, from off which flakes have been struck.

NEW EXPERIMENTS WITH SOAP BUBBLES.

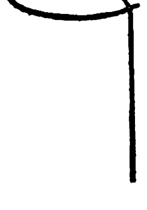
BY JOHN BROUGHTON, B.SC.

OUR subject is not of very difficult or complex manufacture. It is very easy to take a little soap, and shake it up with some soft water in order to form a lather, to take a tobacco pipe and dip it in the solution, and then the foundation of the bubble is made. For across the bowl of the pipe the soap, dissolved by the action of a cause of whose nature we know but little, has enabled the water to form a film, which, liquid though it be, is braced with a drum-like tension. This strain, whose existence can be readily demonstrated, would, if the soap were not present in sufficient quantity, cause the film to break immediately by its own contractility. Now blow through the pipe, and the liquid membrane will be swelled out, its capacity for expansion far exceeding caoutchouc, and the thing of beauty grows rapidly to its maturity, and glows with all the magnificence of its perfections of colour and form, changing every second in the former, until the limit of its strength being reached, fragile as lovely, it vanishes into invisible spray, leaving its name as a byword for beauty without substantiality. To make evident this contractile force of the film, which is at once the cause of its existence and destruction, it is only necessary to blow a bubble with a moderately wide glass tube instead of a tobacco-pipe, and when it has attained to considerable dimensions, to present the end of the tube to the flame of a lighted candle, when the contractility of the film will expel the contained air with such force as to extinguish the candle. If, instead of expanding the bubble to its limit of strain it be dexterously jerked off its parent pipe, by virtue of the same cohesive force it instantaneously closes the rent made in its side and floats a short time, a sphere of nearly mathematical perfection; but the contact of a foreign body destroys at once the uniformity of tension on which its existence depends, producing undue strain at one particular part, and so the unmanageable beauty commits suicide at a touch. If our plaything escape the profaning touch of anything less fairy-like than itself (and I may here remark that they have a great dislike to touching one another, being brought into actual contact with difficulty), it contains within its own constitution elements of destruction. For the film of which it is made, thin though it be, is liquid, and must, therefore, obey the liquid laws; hence the solution gradually runs down to the lowest point, till the upper surface becomes so thin that it can no longer support the strain to which it is exposed, and the

bubble by bursting resolves itself into the simpler form of spray. Besides this, as will subsequently be shown, the film is of excessive tenuity, and the rapid evaporation of liquid from its comparatively enormous surface, soon reduces its thickness to the bursting point. In fact, a soap bubble depends for its being on the accurate adjustment of the equilibrium of many component forces, each of which acting alone would be its destruction, and this equilibrium, being but unstable, is destroyed by the slightest cause. But, on the other hand, if these conditions of its existence be not interfered with, a soap bubble will bear an amount of rough treatment that is surprising in a being otherwise so ephemeral.

Thus our bubble, though a charming thing while it lasts, has such a fragile nature that it can with only the greatest difficulty be employed for any long-continued observation; and for this reason many attempts have been made to discover some means of prolonging its existence. For though generally only considered as a toy, it has already been found to have its uses. Newton spent much time in endeavouring to discover the cause that produced its glorious tints, and how well he succeeded is known to most of my readers. Faraday made soap bubbles the vessels for containing the gases between the poles of the electro-magnet in his great experiments on the magnetism of gases. As a means of prolonging the existence of the bubble, Brewster* recommends the addition of some sugar to the solution, which, by somewhat diminishing the fluidity, has some effect, and makes it slightly more available for optical purposes. But the successful method is that employed by M. Plateau, the Belgian physicist, who, finding a liquid film necessary to his researches on the deportment of liquids freed from the influence of gravity, invented a solution which forms bubbles of a beauty and permanence almost incredible. The recipe for this solution in its most perfect form is as follows:—

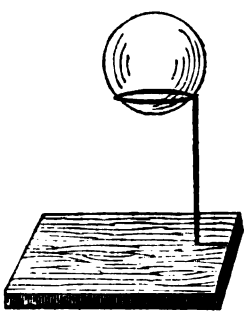
Dissolve one part of pure oleate of soda in fifty parts of distilled water, and to every three volumes of the clear solution thus formed, mix two volumes of pure glycerine.



This mixture, used instead of soap and water, with a common tobacco-pipe, gives bubbles whose tints are truly gorgeous, and which are best observed in the following manner:—Take a piece of iron wire, about the thickness of a darning needle, and after cleaning off any rust with sand-paper, bend it in the form here given, the diameter of the ring being about $1\frac{3}{4}$ inches. This is readily managed by wrapping it round any convenient

* *Optics.* Ed. 1853, p. 119.

cylinder, such as a broom-handle, leaving the perpendicular portion about four inches long, to serve to affix it to a piece of wood as a foot, the wire ring being a support for the bubble.



To place a bubble on the ring it is only necessary to blow one whose diameter is about one and a-half times that of the ring, and then by means of the pipe allow the bubble to rest lightly on the ring at one point, after which, by continuing to blow, the whole of the circumference of the ring can be brought gently in contact with the bubble without injury to the latter. When this has been accomplished, the pipe can be withdrawn by slightly slanting the bowl of the pipe with one edge towards the bubble, and thus removing it, when the latter remains comfortably resting on the ring. The above is easier to perform than describe, since the bubble has now a comparatively robust constitution, and bears a deal of handling. If any difficulty be experienced after one or two trials, it will be found to disappear if the ring be first well wetted with the solution to remove any traces of grease.

When the bubble is thus established, there is no present fear of its bursting, for if it be made with well-prepared materials, it will possess wonderful durability. When shielded from draughts by being covered with a glass shade, it forms an ornament for a drawing-room. Their duration in a pure atmosphere varies generally from an hour and a half to four hours, but occasionally they last much longer. On one occasion a bubble of fine dimensions remained for twenty-seven hours before bursting. Several bubbles on rings placed in a bright light form quite a blaze of beauty: their colours are best seen by arranging them on a black ground, in order that they may be visible by reflected light only, by which the tints, for optical reasons, are seen in much greater brilliancy.

The extraordinary permanence of our now improved plaything depends greatly on the purity of the oleate of soda. This substance, which is merely the soda soap of a peculiar fatty acid, requires, for its preparation in a state of purity, some chemical skill, and the employment of a process which may be found in the manuals of organic chemistry. The following process, however, gives it in sufficient purity for most purposes, and is easily carried out. Take some good sweet almond oil, such as is used by clockmakers and gunsmiths, put it into a convenient vessel, such as a porcelain basin or a clean

iron saucepan, and mix it with about one-and-a-half times its bulk of a strong solution of caustic soda; then heat it to boiling for some time, keeping it well stirred. The oil will thus gradually, by the action of the alkali, be converted into a soap. The heating must be continued till all the oil has been decomposed. This may be ascertained by dissolving a few grains of the mixture in water, when, if any unconverted oil be present, it will be seen to float. If after some time the oil still separates, more soda must be added, and the boiling continued till the desired end is attained, some excess of soda being always necessary. The mixture should then receive the addition of an equal bulk of water, so as to bring it into complete solution, and the whole allowed to cool, when a quantity of white soap will separate from a clear liquid. This soap should be strained and squeezed on calico, till no more liquid can be pressed out. Then it must again be dissolved in hot water, and a little more soda added, and allowed to cool. It will now again separate, and must be pressed as before, till the cake of soap is quite hard, when it will be pure enough for making the solution.

Should the foregoing process (which is less troublesome in practice than its description appears to indicate) be found too difficult, there is yet another plan which, though not quite so successful, is far more easy. It is thus:—Shred finely 150 grains of Castile soap (which can be procured of any druggist), and shake it up in a bottle with half a pint of distilled or pure rain water until it is at length dissolved, then allow the turbid solution to settle, and filter through blotting-paper. The clear solution can then be used to mix with glycerine instead of that of the pure oleate.

I will now suppose a bubble made with our solution, and successfully placed on its ring. It will after a few minutes be glowing with gorgeous colours, which vary almost every minute from the richest violet to the most brilliant orange. Now darken the room. Then take some common spirit (brandy will do) that has previously been shaken up with some common salt, and with it moisten some cotton wool, which inflame. Now look at the bubble illuminated by the yellow light thus produced. Instead of the former lovely tinted sphere we see a yellowish thing, and on a closer inspection, we find that the parts formerly the brightest are now marked by streaks and smears of a dead black, which are shifting about continually. They are not beautiful certainly, but are curious when we remember that they mark the lines and surfaces of equal thickness where the yellow light, by reflection from the two surfaces of the film, is made to extinguish itself, and produce the darkness. If instead of a salted spirit

flame, a bull's-eye lantern with a piece of red glass be used, so as to view the bubble by red light, a similar effect will be seen. Those parts which are dark by red light are green by daylight, for then the red rays are blotted out of the composite white light, leaving the green ones.

When our bubble's life has lasted some considerable time, it commonly happens, especially if shielded from draughts by a glass shade, that a small purple spot makes its appearance at the uppermost portion, owing to the liquid draining away to the antipodal extremity. This spot when it first appears is scarcely larger than the point of a pin; but small though it be, it indicates the eventual decay of the beautiful sphere; for by very slow degrees the spot enlarges, and bright yellow points, like minute flecks of gold, appear within its circumference. During the enlargement of the purple spot, a series of Newton's rings, of every brilliant rainbow tint, forming concentric circles for about 25° round it as centre, gradually make their appearance, while, less definite in position and extent, the colours of the remainder of the bubble are constantly varying from one bright shade to another. In fact, nothing can be more beautiful or interesting than to watch the slow consumptive changes which end in the dissolution of our plaything. It is, from these wonderful optical effects alone, a source of unwearying interest. Slowly the spot increases, the velvety purple becomes very nearly black, and, in addition to the bright golden spots above-mentioned, others appear of intense blackness, which resemble minute holes. Frequently the central spot attains a diameter of three-sixteenths of an inch, with edges looking like a mosaic of gold and gems; but while we are gazing on the changes which occur almost every second, it vanishes, leaving no trace, save a film spread over the wire ring. It frequently happens that these effects of the central spot and rings are not at first obtained, but a few trials, and perhaps a slight addition either of the oleate solution, or of glycerine, will ensure success, which will well repay the expenditure of trouble. These changes, from the first appearance of the spot to the destruction of the bubble, commonly occupy about twenty minutes.

Another of the many interesting diversions which the bubbles furnish is that of filling them with a gaseous mixture, which will just neutralize the influence of their gravity. For this purpose a bladder or gasholder, provided with a stop-cock, should be filled with a mixture of about one volume of common coal-gas and eight volumes of air. By means of an attached tobacco-pipe bubbles of about three inches diameter can then be blown with this mixture; and after detaching, by touching with a wet finger the drop of liquid clinging to their under

surface, they can be detached from the pipe and started floating. If the balance be well-adjusted, which is readily accomplished by making the balloon a little smaller or larger, according as the gas employed be strong or weak, it will hang, like Mohammed's coffin, self-suspended in the air, if the latter be quite still; but being a very sensitive indicator of currents, it will generally move in some particular direction. Thus it will slowly creep along the walls of the room, mount to the ceiling, and descend by the other branch of the current that carried it up, or it will go so near the ceiling that its destruction appears inevitable. But not so; there being always a cushion of motionless air on the surface of large objects, it will float out of danger in a most surprising manner, unless some asperity of surface should attack it. If it escape the latter danger, it will remain floating and creeping about till it gradually loses some of the coal-gas by solution in its liquid sides, when, becoming heavier, it sinks and bursts.

Notwithstanding the sensitiveness of our bubble to unkind usage, it possesses in some respects a very remarkable invulnerability. It is well known that ghosts and other apparitions do not sustain the least injury either when they are shot at, chopped at with battle-axes, or pierced with sword thrusts—in fact, this peculiarity is invariably demonstrated in perfect ghost stories. This peculiarity is shared by the fairy-like subject of the present article. Pierced with needles, thrust at with knitting-pins, they remain without a wound, nor does a scar remain to testify the gash. Drops of water and small shot may be sent through them without producing any perceptible symptom of inconvenience; indeed, they may be pierced with a pen-knife (in a manner that would reduce a less eerie thing into slices), with scarcely any disturbance of its unsubstantial being. But like the silver bullet which infallibly destroys a ghost, so does a particle of grease on any of the above offensive weapons destroy our bubble, for then it requires but a single touch, and all is over—it vanishes; its liquid sides can no longer adhere, as though its stainless nature could not endure the impure contact.

This property of invulnerability suggests, however, to the unpoetical mind some curiosity as to the thickness of this strange liquid film that forms our bubble. It certainly seems at first almost impossible to effect a measurement of so intangible a magnitude, and of a substance which cannot, from its nature, be put (as in the case of gold leaf) into the balance and weighed. It is true that there is furnished by the light which produces such splendid tints on reflection from its two surfaces, an indirect means by which the distance that separates them can be ascertained, supposing the angle of vision at

which a definite colour is visible, and the refractive index of the solution be known. But this method does not readily apply to our present inquiry, and would only be fairly applicable to thicknesses producing the circles of colour produced at the upper part of the bubble, which are described above, since the same colour may be produced by various thicknesses of film.

Again, a slight examination of the bubble shows that the colours vary considerably even in spaces only a line square, especially when it is well expanded. This circumstance renders the determination of the mean thickness of the bubble by the optical method practically useless. It is, therefore, necessary to have recourse to some other indirect means of weighing and measuring. It is true we cannot put our bubble into the balance, but still there is a device by which we can make a determination so readily that any reader can make a direct experiment on the thickness of the film of any particular bubble. The method I refer to is to blow a bubble with a gas of known specific gravity, which is less than that of air, and of such a size that it will neither ascend or sink in the air, whose specific gravity is known. The size of the balloon being known, the weight that its contained gas will support is readily calculated, and this gives the weight of the balloon. This being known, the thickness of a spherical shell which such a weight of liquid would form of the diameter of the balloon is readily determined by a calculation, and this is equal to the mean thickness of the balloon. From such experiments the writer has found that bubbles have a thickness varying from $\frac{1}{15,000}$ to $\frac{1}{31,000}$ of an inch*, the latter number representing that of a thin bubble. Wonderfully thin as is their dimension, it is greatly exceeded by that of gold leaf, which

* The following illustrates the method:—

A bubble, carefully freed from drops of liquid at its lower pole, and of 3·5 in. diameter, filled with a mixture of one volume of hydrogen to sixteen volumes of air, showed no tendency to ascend or sink.

Let s = sp. gr. of hydrogen = 0·0691.
s' = sp. gr. of the bubble solution = 1·1.
g = number of grains in a cubic inch of water = 252·456.
t = thickness of film.
r = radius of balloon = 1·75 inches.
w weight of balloon.

$$\text{Then } \left(\frac{4r^3\pi}{3} \times \frac{31}{100}\right) - \left(\frac{4r^3\pi}{3} \times \frac{31}{100} \times \frac{16+s}{17}\right) = \frac{4r^3\pi}{3} \times \frac{31}{100} \times \frac{1-s}{17} = w$$

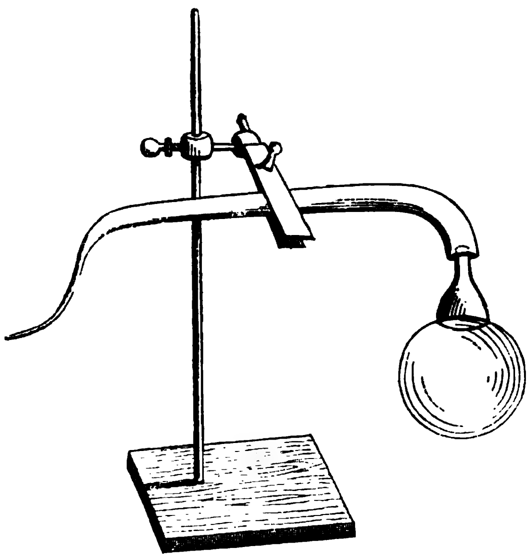
Also $4r^2\pi\, t\, g\, s' = w$ very nearly.

Whence equating the two values of w, and reducing, we obtain

$$t = \frac{r}{3gs'}\,\frac{31}{100}\,\frac{1-s}{17} \text{ whence substituting values } t = \frac{1}{28124}\text{in.}$$

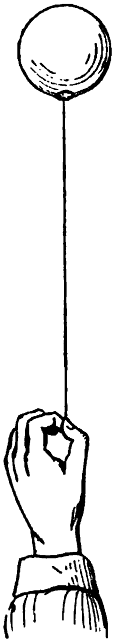
has been obtained of a thickness not exceeding one two-millionth of an inch, while gold leaf itself is exceeded slightly by the thinness of the film of the black spot I have described as being formed on the upper pole of an undisturbed bubble, which has probably a thickness even less than three eight-millionths of an inch. When we consider that this film yet contains only about a fiftieth of its weight of soap, a substance of highly complex atomic constitution, we obtain some notion of the almost infinite divisibility of matter.

Thin as is the film that forms our bubbles, yet its equality of tension is such, that by dexterous management they may be

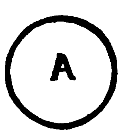


blown to a giant size. For this purpose the tobacco-pipe must be discarded, as it neither gives a large enough film to commence with nor supplies air with sufficient rapidity. A small glass funnel, of about $1\frac{3}{4}$ in. in diameter, cemented by some marine glue, with its mouth downwards, into a glass tube connected with a double-action bellows, must be employed. The connection between the tube and bellows should be made with a caoutchouc tube, and supplied with a stop-cock or clamp for regulating the supply of air. A small flat basin, containing some of the bubble solution, should be employed to form a film across the mouth of the funnel, which is then expanded by careful supplies of air from the bellows. When the bubble has

attained a considerable size it can be supplied with more material by carefully moistening the edges of the funnel with a small brush dipped in the solution. By these means the size of the bubbles can be increased to a wonderful extent (on one occasion a diameter of 1 ft. 7 in. was attained), and an object produced, of whose splendour and beauty no description can give an adequate idea. Its great globular surface has spaces of large extent blazing with one particular tint, to which the colour of another part vies in contrast, and the whole produces an effect which is well worth some pains to procure. This experiment should be performed in as still an atmosphere as possible, since the larger the surface of the bubble, or rather globe, the more sensitive it becomes to injury from currents.



There are so many other interesting experiments to be obtained from our toy, that it would be easy to fill many more pages with their description and discussion; but I will now only describe one more, which is the most fascinating of all. This consists in harnessing the bubble, and thus making it an actual balloon. This is a matter so easy of performance, that the only wonder is that it has not been done long ago. The following is the method :—



Take some foreign post paper, not too highly glazed, and cut out a circle of the size A; then by means of sealing-wax attach a piece of fine thread to the centre, using as little wax as is consistent with a secure attachment. Allow the paper disc, thus prepared, to steep for some time in the bubble solution, until thoroughly moistened, and it is then fit to attach to the bubble. For this purpose, blow a small bubble with the tobacco pipe, and bringing the surface of the moistened paper disc gently against the bubble by means of the thread, in the manner of a boy's sucker, it will immediately adhere, without at all affecting the health of the bubble, which can be blown to its usual size, and gently detached from the pipe. It will then remain attached to the thread, and can be swung about at pleasure. When this process has been managed with care,

there is no difficulty in blowing a bubble by means of a coal gas supply (using a caoutchouc tube for connection), and attaching the disc as before, detaching it from the pipe as soon as it has attained a considerable ascending power.

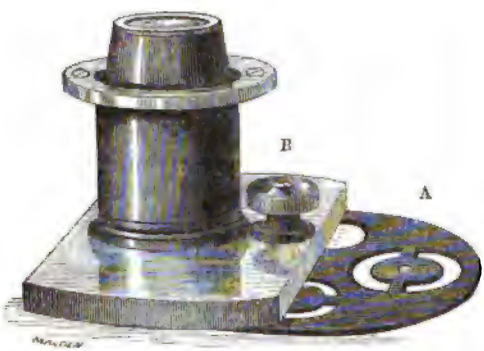
Under these circumstances it can be carried about at will, floating in the air as high as the thread will allow, forming the most delightful plaything that can be imagined. It is very amusing to balance it by means of a considerable length of thread, preserving a slight preponderance of the latter, so that it slowly sinks. It may then be thrown towards the floor, to which it descends until the excess of string rests upon the ground, when the balloon remains gracefully suspended in the air, waving about at each breath, without at all appearing to suffer from its shackled condition. The unusual appearance of such a balloon has a singular effect, which is increased if a fibre of unspun silk be employed in the place of the visible thread. In the same manner a car of silver foil can be attached to the paper disc, and a miniature balloon ascent performed. A balloon suspended in the above manner is a very sensitive indicator of air currents. On this property a most interesting experiment can be performed by placing in the middle of the room a burning lamp, and bringing a balloon, nearly counterpoised with excess of thread, within its influence, when it will be slowly drawn towards the lamp, and will then immediately ascend with the current of convection, as though it would be dashed against the ceiling; but not so, it will be carried round by the current, after an apparently hair-breadth escape, and will descend in the stream of colder air, only to be again dragged towards the lamp to perform the same round.

These are only a few of the illustrations of natural laws that may be obtained by means of our plaything; but the above descriptions will enable the reader, if he care to repeat them in a practical form, to devise many more, and to share in the pleasure and instruction these experiments have afforded the writer.*

* The solutions whose preparation is described above may also be obtained of Mr. Ladd, optician, Beak-street.

MR. HIGHLEY'S CONDENSER.

Mr. Highley has devised a modification of Webster's condenser, which possesses some very striking and important advantages. The drawing which we append shows the form of the instrument. Its optical part consists of "a double concave lens cemented to a very deep crossed lens," and the mechanical arrangements are efficient and complete. The advantage of this new condenser over the old patterns is not that it is superior to them under all conditions; indeed, for some purposes, Powell and Lealand's form, with its enormous angle of aperture, would be preferred; but the Highley condenser meets a greater number of everyday requirements than any other condenser yet produced. It works well with powers from one inch upwards to the highest. When very low object-glasses, such as three inch, are used, it must be removed whether light or dark ground illumination is desired; but the greater majority of microscopic observations are made with powers of from one inch upwards, and for these the new condenser is very efficient. With an inch or two-thirds, for example, it affords an excellent light ground illumination, instantaneously changed to a good dark ground one by moving the circular diaphragm carrying the stops. If a quarter or even a one-twentieth has to be employed, the condenser need not be changed, as it works well with high powers, bringing out delicate diatom markings, and the wedge-shaped patterns on the Podura scale, with the light marks so admirably shown in Mr. Richard Beck's engravings.



Mr. Highley's Condenser.—Upper side, showing the revolving diaphragm A, and the milled head B, which opens or closes the shutter shown in the under view.

Mr. Highley's Condenser.—Under side. The lozenge-shaped opening represents the shutter partially closed, and shutting off peripheral rays.

If a student had a complete set of illuminating apparatus, including Powell and Lealand's large angled condenser, the parabolic illuminator, etc., etc., we do not say that for some special objects he would not avail himself of these contrivances in preference to Mr. Highley's; but the latter has the great practical advantage of being adapted to a wider range of power and purposes, and is thus calculated to save an immense deal of trouble and loss of time in shifting apparatus.

The distance of the condenser from the object is regulated in the best pattern of Mr. Highley's condenser by a rack adjustment; and in addition to the set of stops in the circular diaphragm, he has introduced a double shutter on the plan of Mr. Collins' clever adjustible diaphragm, which appears, as we before stated, to be a revival of an arrangement of Dolland, for which Mr. Collins deserves much credit.

This shutter, by varying the size of the aperture, is intended to correspond in action with the series of round holes in the diaphragm of an ordinary condenser. To some extent it does so perfectly, and it will be found very useful; but a small stop only admitting central rays in the ordinary pattern appears to us preferable on some occasions. The abruptly-rounded form of the bull's-eye in Mr. Highley's contrivance is not favourable for the transmission of a small pencil of central rays only; and when trying to make it answer this purpose, we have not succeeded in avoiding a certain amount of glare.

The new condenser requires a little practice, and some deviation from the mode of using the old condenser, to work well. Thus we have obtained the best definition of the Podura scale by using a central stop, and partially closing the shutters of the diaphragm. A stop which admits light from a half-circle of the margin of the lenses only, is very useful for many purposes, and as all the stops are large it is often desirable to try the effect of throwing them out of centre so as only to use portions of them.

We feel convinced that microscopists will appreciate the new condenser, and it will save many a student from the necessity of purchasing several distinct pieces of apparatus, costing in the aggregate a great deal more money than the price of Mr. Highley's instrument.

M. CHACORNAC ON THE MOON.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

There has probably never been a time since the invention of the telescope when selenography has received so much general attention as at the present moment; and on this account our astronomical readers may be interested in learning the conclusions which have been deduced as to the nature of the lunar surface by the eminent French astronomer, M. Chacornac, to whose care has been consigned the great silvered-glass Foucault speculum of about 2¼ English feet in diameter, and who is carrying on his observations at Ville-Urbanne, near Lyons. What aperture and power he may have used does not appear; or, indeed, whether this particular instrument was employed in his researches; but they who have tried the effect of only twelve inches of silvered glass will not readily suppose that the whole of that magnificent mirror could have been used to collect the lunar rays.

This celebrated observer begins by telling us, what was stated many years ago as the experience of English astronomers, that the forms of the lunar craters become less regular when scrutinized with great optical power; he finds that their structure then appears more similar to that of analogous terrestrial formations than might have been previously supposed, and considers that astronomers may undertake an "orographical" examination of our satellite, as geologists have done of the primary planet. The disadvantage is indeed great of having to contemplate objects at a distance of 240,000 miles, and instead of distinguishing strata by the microscopic shells which they contain, being obliged to reckon upon 120 yards as the *minimum visibile* in lunar dimensions. It is, however, somewhat counterbalanced by the opportunity of comparing in a single view the formations of an entire hemisphere. Much may be learnt from shadow, as to the minuter details. There are steppes in Central Asia, where, from the uniformity and whiteness of the soil, the shadow of a man at sunset visibly lengthens his stature one hundredfold; and such is the case on the moon. No sensible penumbra attends the shadows there, and owing to the absence of reflected light from an atmosphere, they are clearly defined, and, under a very low angle of illumination, give us intelligence of many irregularities of form, too minute for direct observation. By such an examination we become acquainted with the fact, that the lunar surface falls naturally into two contrasted divisions. The surface in relief, which has always been

considered analogous to the continents of the earth, is clearly distinguished from the level portion by its porous structure and its great reflective power, as well as by its elevation; while the other is sombre and smooth, and presents, as Sir J. Herschel has said, a completely alluvial character. Nevertheless, there is nothing whatever to justify the ancient appellation of *seas*, and the expression *alluvial* is employed only in default of a more appropriate term. In fact, there is not the slightest appearance of any fluid, or body susceptible of evaporation, on the lunar globe, though every portion of it is exposed to the direct solar radiation during 343 consecutive hours. The surface of the continents everywhere displays a character of eminently volcanic, or, at any rate, igneous origin. For example, in the lunar *Caucasus*, *Apennines*, and *Alps*, we find a region overspread with little hillocks in very close proximity, giving the aspect of a soil violently agitated by a species of ebullition followed by rapid cooling. In other districts the volcanic continent appears ruined to such a depth by the multiplicity of craters, that they have broken out in each other's interiors. In the S. part of the disc, it is not uncommon to observe three or four contiguous rings, which have overthrown and defaced one another in succession; for instance, the exhausted soil of the craters *Metius* and *Fabricius*. The raised portion of the continents has everywhere a rough, rugged, puffy character, resembling that of iron dross; the rounded hill-tops, as well as the crater-rings, are perforated by a multitude of little cavities and pits, indicating a kind of most vehement ebullition. The walls and environs of *Metius* and *Fabricius*, which may be cited as types of this sort of formation, are so "riddled" by these perforations, that they appear, under an oblique illumination, to possess a structure exactly like that of the most porous pumice-stone. In some neighbourhoods the strictly volcanic character predominates, in others the more rounded mountainous aspect; but the continental regions never offer the smooth, uniform appearance of the so-called seas, whose aspect is that of hardened plaster, or, still more accurately, that of immense plains of dried mud.

From these strongly-marked physiognomical characters it is possible to recognise regions to which the same origin may be ascribed, even though they may be separated by a vast extent of the so-called alluvial plains.

These two kinds of surface are more intermingled than the terrestrial continents and seas: in the centre of the enormous levels which form more than two-thirds of the visible hemisphere of the moon, we meet with numerous archipelagos and unnumbered islets, apparently the remains of ancient continents

buried beneath the maritime soil; and, besides these, we find, at the line of junction of the two kinds of surface, very curious appearances of "erosion" and submersion of the shore, perfectly analogous to that of the Island of St. Paul, in the Indian Ocean. To render this more intelligible, we may remark a characteristic distinction between the usual form of the lunar and the terrene crater. The latter generally occupies the top of a conical mountain, and the bottom of the cavity is never far beneath the summit; the depth of the crater being only a small fraction of the height of the mountain. On the contrary, the bottom of the lunar crater, in its original condition, is always deeply depressed below the level of the soil on which the cone of eruption is raised, so as to give it, when of small dimensions, some analogy with a vast conical well. In studying, for instance, those of not more than 300 to 1000 yards in diameter, and having a continuous ring, we come to the conclusion that this is the result of a single explosion, which raised the surface in the form of a bubble, and deposited it round the orifice of eruption. But, to return to the phenomena of encroachment to which such formations have conduced, we find on the "sea-shores," and especially where the higher ground sinks by a gradual declivity, the interiors of certain partially-destroyed rings filled up by a compact mass of alluvial soil, precisely as the bottom of the crater in the Island of St. Paul is now invaded by the ocean. In such cases the shore takes the form of a vast semicircular bay, whose entrance is partly obstructed by the remains of the ring, exactly as is the case with the terrestrial volcano in question. In examining these extremely striking and interesting details, we shall meet with what may be compared to marshy formations, immense partial inundations, the complicated particulars of which are not within the compass of this sketch: these marshy formations consist principally of volcanic hills, whose bases are covered by sedimentary soil; but the most important fact connected with them is the presence of other neighbouring craters, which, though on the same level, are entirely empty, with outlines usually unbroken, and interiors excavated considerably beneath the marine surface, affording a singular contrast to the ruined aspect of the buried craters. The one have nothing left standing but the thickest portion of their ramparts, and projections bearing the marks of erosion; the ejections of the other exhibit themselves regularly around the cone of eruption as currents of lava, preserving the smallest details of their edges, and winding and spreading along the shallow depressions of the plains: so that it is perfectly evident that these latter craters have been formed subsequently to the consolidation of the ground which supports them, and which in

turn has moulded itself upon the cavities of the more ancient eruptions.

As types of each of these forms, completely different and characteristic of successive epochs of formation, we may refer to *Herschel* or *Alpetragius,* and *Ptolemæus.* These show especially the ordinary diminution of magnitude of the more recent as compared with the buried craters. In fact, the diameter of *Ptolemæus* is more than forty, while that of *Herschel* is less than four leagues, although the height of the eruptive cone of the latter is more than 200 metres higher than the loftiest peak of *Ptolemæus* ;* while the minute exploration of the "sea-shores" proves that in all cases where the continental ground has offered an accessible opening, an influx has taken place from without, and the adventitious material has risen there to the general level which it preserves [sufficiently, at least, for the present argument] throughout the visible hemisphere.

Among the numerous results of this kind of general *diluvium,* we discover, in an immense number of points on the plains, evidence of the subsequent levelling of igneous products; and these levellings are the more distinguishable for three reasons: the continents have a much greater reflective power than the *maria;* their relief is usually very marked and sharp; and their structure, whether as mountains or craters, always has a circular type and a scoriaceous consistency; while, on the other hand, the slight protuberances of the *maria* are merely oblong hills of slight elevation, and uniform [general ?] rectilinear direction. The configuration of these hills, whose material is exactly similar to that of the plains, is perfectly comparable to the ridges of sand thrown up by our tidal waves on broad, sandy beaches. The linear shape of these slight undulations, together with the difference of their structure, leaves no doubt as to the nature of the emergent spots, marked by strong relief and sharp outlines, which occur scattered in the centre of the lunar oceans.

Among other characteristics of the primitive surface, we notice immense rings, whose crests alone project above the surrounding plain by some hundreds of yards—circular ramparts, the last visible vestiges of great buried craters: and these are cut through by considerable breaches, which permit us to follow the level of the maritime soil where it penetrates their interiors, and to remark the absence of the slightest difference in surface or structure. We might suppose that we were looking upon the remains of an archipelago similar to the Phlegrean Fields, invaded by a fluid but subsequently conso-

* The French league is very nearly equal to 2½ English miles. The French mètre is 3 feet 3·37 inches, English measure.

lidated mass. We may refer to the two rings, *Kies* and *Lubiniezky*, as curious types of this formation. Each of them has ramparts of about forty-five leagues, rising sharply in the midst of an immense desert to a height of two or three hundred yards.

It is known that while some craters exhibit only a simple cavity, others possess a central peak. We may further remark that in the heart of the continents flat-bottomed craters exist, the peaks of which, half-emergent from the sedimentary mass, demonstrate that the craters have been invaded by maritime soil; and we may notice cases where all traces of central peaks have disappeared beneath thick beds of deposited matter.

To give an idea of the gigantic proportions which characterize this kind of formation peculiar to our satellite, M. Chacornac specifies the crater *Schikard*, lying towards the S.E. limb; the interior, which is upwards of sixty-five leagues in diameter, would have to a spectator in the centre the aspect of a boundless desert; as the speedy rounding-off of so small a globe would depress the rampart out of sight in every direction, though attaining on the N. a height of more than 10,500 feet.

After this brief examination, it remains to point out a fact enabling us to class the craters of different dimensions in a chronological succession. In a great number of craters such as we have just described, we find that a portion of their bulwarks has disappeared from the effects of subsequent eruptions, whose foci have broken out even through the ring itself, and produced craters, usually entirely empty; and the more recent date of these outbreaks is also proved by there being no trace of the destroyed portion of the ring, while the ejected products of the more modern are superimposed on those of the earlier crater. The dimensions, also, of the encroaching basin are always inferior to those of the original cavity. This, which is characteristic of the lunar formations, may be considered as a general law [almost ?] without exception.

We may distinguish, then, three clearly marked selenological epochs. The primitive is that during which immense vesicular upheavings have given rise to crater-like rings of more than 300 leagues in compass, and around which we perceive clear traces of entangled circumvallations [*circonvallations enchevêtrées*]. To this period would have succeeded that of a general diluvium, forming deposits analogous to the alluvial strata of the earth. This effusion has buried, under a brown mass, more than two-thirds of the visible surface of the moon, including the interiors of all the great craters, displaying itself from one extremity of the hemisphere to the other, apparently on the same level. Subsequently to this second period came

on, in every direction, and through every kind of surface, a multitude of eruptions, producing small deep craters resembling conical wells, whose interiors are entirely free from all alluvial deposit. Finally, in the intervals of these three great epochs, other phænomena are met with, which, M. Chacornac informs us, will form the subject of a future communication. In conclusion, he states his opinion that this great diluvium was probably due to the precipitation of the gaseous matter of the lunar atmosphere; the cooling of the globe having proceeded to a certain extent, atmospheric pressure would favour the precipitation of gases and vapours in the form of an universal rain, filling up the great craters, and followed by a process of sedimentary consolidation.

It will be evident that an objection to this very ingenious and striking selenological theory will be found in the sharp and precipitous aspect of many of the great ancient rings, whose angular relief ought to have suffered more serious degradation from the loss of so much sedimentary matter as would have been expended in filling up their interiors without external communication. *Plato* and *Archimedes* may be cited as prominent instances. It may be thought, too, that there is so gradual a transition from the broad flat ancient wall-plains to the deeply-hollowed concavity of the more modern craters, that it can scarcely be brought into accordance with the supposition of such clearly separable epochs? Nevertheless, the memoir is of so interesting a character, and proceeds from such high authority, that we feel sure our readers will be glad to have it placed before them, and will look forward with pleasure to future communications from its eminent author.

OCCULTATIONS.

Dec. 3rd, 130 Tauri, 5h. 14m. to 5h. 38m.—6th, A^2 Cancri, 8h. 12m. to 8h. 48m.

AIDS TO MICROSCOPIC INQUIRY.—No. VIII.

Honey.

Among the objects which are common in family stores, honey may be mentioned as capable of affording considerable microscopic entertainment.

The bees obtain from the nectaries of flowers a number of substances which may be recognized in honey—a substance composed of different kinds of sugar, a small quantity of gum, mucilage, a little wax, an acid, pollen grains, etc.

Sugars are compounds of carbon, hydrogen, and oxygen. *Cane sugar*, or the sugar in common household use, consists of twelve parts of carbon and eleven each of hydrogen and oxygen. It is very soluble in water, crystallizes in four or six sided rhomboidal prisms, and acts upon polarized light so as to produce a right-handed rotation.*

If the elements of water—one equivalent of oxygen and one of hydrogen—are added to cane sugar, *Fruit Sugar* is produced, which does not crystallize, is more soluble in dilute alcohol than cane sugar, and produces left-handed rotation of polarized light. In this sugar we have twelve equivalents each of the three components—carbon, hydrogen, and oxygen. A third kind of sugar contains two equivalents of water added to fruit sugar. This is *Grape Sugar*, found in dried fruits. It crystallizes in cubes or square tables, is less soluble than cane sugar in water, but more so in alcohol, and produces right-handed rotation. Another kind of sugar, *Sugar of Milk*, contains fourteen equivalents of carbon, nineteen of hydrogen, nineteen of oxygen, together with five equivalents of water. It crystallizes in four-sided prisms, is not, like those previously mentioned, directly susceptible of alcoholic fermentation, and produces right-handed rotation. There are several other sugars, which will be found described in *Miller's Chemistry*, from which the preceding information is condensed.

* Suppose the experimenter to use two Nicol's prisms, one as polarizer and the other as analyzer, bodies capable of inducing circular polarization will, when inserted between the prisms, twist the plane in which the light vibrations take place. The explanation given in *Ganot's Physics*, translated by Atkinson, is as follows:—"When a ray of homogeneous light traverses the first Nicol, it becomes polarized in a plane at right angles to the principal section. Its vibrations are all in the plane of the principal section, and therefore are not transmitted by the second Nicol when the planes of the two principal sections are at right angles to each other. But by passing through a plate of quartz (a substance capable of producing rotation) in the direction of the axis this is changed: the plane of vibration experiences a uniform rotation in such a manner that its path becomes that of a screw rotating round the axis of the crystal." Some substances cause this screw to have a right-handed twist and others a left.

The sugars mentioned vary in sweetness. Cane sugar is the sweetest. Fruit sugar, which is abundant in treacle, comes next. Starch sugar or grape sugar is so inferior in this property that, according to Professor Miller, two and a half pounds of it only produces as much sweetening as one pound of cane sugar. Milk sugar comes lowest of all. It should be stated, in reference to fermentation, that, when cane sugar is acted upon by yeast, it is converted first into fruit sugar and then into carbonic acid and alcohol.*

Honey contains a great deal of the uncrystallizable fruit sugar, and, when quite fresh, is, as is well known, a transparent liquid. When removed from the comb, part of the sugar soon passes into the form of grape or starch sugar, and crystallizes in patterns more or less like the four or six sided prisms of cane sugar.

If, therefore, a little drop of honey, that has been some time out of the comb, is placed upon a slide covered with thin glass, and viewed with an inch or two-thirds objective, it will be seen to contain a great quantity of more or less perfect sugar crystals, which become splendid objects with polarized light and the use of the selenite stage.

In addition to the sugar crystals, grains of pollen from the plants which the bees have visited will be discerned, and it is interesting for those who live in the country to collect pollen grains for themselves, and compare them with those introduced into the honey by the bees.

Honey, adulterated with potato starch, will be detected by the form of the starch grains, and by the cross they give with polarized light. When common sugar is added to restore the sweetness of adulterated honey, Dr. Hassall tells us it may be detected by the thicker and clumsier crystals which it forms.

When bees have access to odoriferous flowers, their honey acquires a special characteristic, which is often exceedingly pleasant. They sometimes visit poisonous plants, and then their honey has deleterious properties, like that which affected Xenophon's soldiers in one portion of their famous march. This sort of honey, partially made from the *Azalea pontica,* possesses in our times the same undesirable qualities.

* *Vide Miller's Chemistry.*

HEART MOVEMENTS GRAPHICALLY DISPLAYED.

BY M. MARCY.

Comptes Rendus, No. 19 for this year, contains a paper by M. Marcy detailing some curious investigations made with an instrument which makes a mark on paper each time it receives a shock from the movement of the heart of any animal against whose chest it is placed. In man the resulting diagram exhibits a number of pointed conical elevations, with recurring irregularities in the ascending and descending lines. The irregularities in these figures mark the motions belonging to the contraction of the auricles, the contraction of the ventricles, and the movements of the valves.

Quite a different form is drawn when the instrument is applied to the land tortoise (*Testudo Europea*). The ascending line is simpler. First a sloping line indicates the contraction of the auricle, then the line ascends nearly vertically to a considerable height to mark the contraction of the ventricle, which, as it gradually subsides, makes a gently descending line longer than the corresponding part of the ascending one. This repeated in succession gives a pattern in which what we may call broad tablelands alternate with deep, open valleys. The heart of the frog impresses upon the instrument a tremulous series of rounded, zig-zag lines.

M. Marcy tried several fishes, amongst them a ray (*Raia alba*), and the pattern yielded was in appearance between that of man and that of the frog.

Crabs, lobsters, etc., afforded a very curious diagram. M. Marcy says, "In these creatures, by reason of the absence of an auricle, we find a single very powerful contraction, that of the ventricle." The figure consists of a repetition of a short horizontal line, then of a long one ascending almost at right angles, then turning over, and descending as abruptly.

The great pecten or scallop afforded a regular figure, consisting of a zig-zag of long descending and short ascending lines, sloping from left to right. The force and duration of the contractions being much less than in the case of the crab, as might be expected from the lower position of the animal.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from Page* 307.)

1702. [i.] Numerous navigators report seeing a comet in the southern hemisphere, between February 20 and March 1. On February 28 the tail was 43° long. At 8h. p.m. in latitude 15° 10′ N. and longitude 116° 45′ the comet bore S. of W. 20° 30′, altitude 8° 40′. On all occasions it was seen in the evening after sunset. Maraldi, at Rome, saw the *tail* for several days at the end of February and beginning of March. —(Struyck, *Vervolg*, Amsterdam, 1753, p. 50.)

1733. On May 17 and 18, a comet was seen by several navigators off the Cape of Good Hope, in the N.W.¼W. quarter.—(Struyck, p. 61.)

1742. [ii.] On April 11, a comet is recorded to have been seen in the S.E. by several Dutch navigators, at sea, off the Cápe of Good Hope. On April 14 the tail was 30° long.—(Struyck.)

1748. [iii.] On April 24, a Dutch navigator, at the Cape of Good Hope, saw a comet at the beginning of Aries, rise in the E.¼N.E. at 4h. a.m. This is probably the comet (rendered invisible at the Cape by a northerly motion) which Kindermanus saw on April 28, at 2h. a.m. at an elevation of 8° above the horizon, in a straight line with δ and a Trianguli and the lighted star of Aries, in longitude 80°, latitude + 28°, and declination + 50°. On May 3, between 11h. and midnight, the comet was near Perseus, and within the circle of perpetual apparition.—(Struyck, p. 100.)

1750. Between January 21 and January 25, Wargentin observed a comet below ϵ and θ Pegasi.—(*Tables Astronomiques de Berlin*, i.)

1783. On December 18, Sir W. Herschel observed a nebula 1m. preceding δ Ceti and ½° N. of that star. He describes it as small and cometic. In his son's great catalogue of 1864, this object is set down as really a comet, not having been since found, though looked for.

1808. [i.] On February 6, Pons discovered a small faint comet between the neck of Serpens and Libra. It was only visible three days, becoming lost in the moonlight. Its movement was rapid and towards the S.—(*Astron. Nach.*, No. 149, vol. viii.)

1808. [iv.] On July 3, Pons discovered a comet in Camelo-

pardus: it was observed only on that night and July 5. The position on July 3, at 15h. 4m. 26s. Marseilles M. T., was R. A. 3h. 10m. 10s. and Decl. + 56° 36′. On July 5, at 15h. 8m. 58s. the R. A. was 3h. 31m. 46s. and Decl. + 58° 19′—(*Monatliche Correspondenz*, xviii. 249.)

1839. On July 14 and 17, an extremely faint comet was observed at the Roman College. It was in Draco, and appeared like a double nebula, or as if doubled into two branches. —(*Memoria Oss. Coll. Rom.*, 1839.)

1846. [ix.] On October 18, Hind observed a comet in Coma Berenicis for more than an hour. Its altitude was low, and being in the morning twilight it was never seen again. Its exact position at 16h. 15m. 11s., G. M. T., was R. A. 11h. 59m. 49s.; Declination + 14° 59′ 32″. Its motion was increasing in R.A. at the rate of about 4m. a day, and diminishing in Declination at the rate of about 11′ a day.—(*Month. Not.* R.A.S., vii. 162.)

1849. [iv.] On November 15, being at sea, in latitude 10° S. and longitude 30° W., the Rev. J. M. Jenkins and others saw a comet, with a nucleus, as bright as Mars, and with a tail curved and pointing to the S.W. It was also seen on November 28.—(*Month. Not.* R.A.S., x. 122 and 192.)

1854. [i.] On March 16, a bright nebulous object was seen by Brorsen. Its position at 8h. 15m. 34s. Senftenberg M. T. was 2h. 30m. 12s., and Declination + 1° 11·2′.—(*Astron. Nach.*, 897, vol. 38.)

1856. [i.] In January, a comet was seen in the N.W. sky at Panama.—(Letter in the *Morning Herald.*)

1856. [ii.] On August 7, an object, supposed to be a comet, was seen in Virgo, by E. J. Lowe.—(*Month. Not.* R.A.S., xvii. 114.) A comet was also seen at Arequipa, in Peru, for a fortnight previous to August 21, for two hours after sunset.—(Letter in the *Times*, October 8, 1856.)

1859. In February, a very faint comet was seen, by Slater, in R.A. 11h. 48m.; Declination + 19° 49′. He saw it again on May 7 and 22, when it had become fainter, not being visible with any aperture below 11½ inches. Its movement was very slow, and seemed to be in a northerly direction.—(*Month. Not.* R.A.S., xix. 291.)

PROGRESS OF INVENTION.

Aventurine.—This beautiful substance, which has long been an object of imitation, is a species of quartz, that contains throughout its mass a number of brilliant spangles of mica. The Venetians very early succeeded in producing a compound which rivalled that formed by nature; and as they preserved the secret of its manufacture, it continued to form a lucrative article of commerce. A mode of making a kind still more exquisite than the Venetian has been recently discovered by M. Pelouze. The spangles in the Aventurine manufactured in the glass works of Venice consist of metallic copper, the mass being tinged throughout a delicate brown, by oxide of iron; and an excellent imitation was obtained by MM. Fléury and Clemandot, by keeping fused, at a high temperature, for twelve hours a mixture containing three hundred parts pounded glass, forty parts protoxide of copper, and eighty parts oxide of iron, and then allowing the mass to cool very gradually. The Aventurine of M. Pelouze is of a light green tint, which is much more pleasing than brown, and is produced by bichromate of potash. He fuses together two hundred and fifty parts fine sand, one hundred parts carbonate of soda, fifty parts carbonate of lime, and forty parts bichromate of potash. The latter is decomposed by the heat into oxide of chromium, and neutral chromate of potash; and the neutral chromate is decomposed by the silex, silicate of potash and oxide of chromium being formed, and oxygen liberated. If an excess of bichromate is employed, the transparency of the product is impaired, and brilliant spangles of sesquioxide of chromium are diffused through it. When the proper proportions are used, the artificial gem obtained yields only to the diamond in lustre; it is hard enough to cut glass, and yet it is worked with great facility. To distinguish it from that obtained at Venice, it has been properly termed "Chrome-aventurine."

The Nature of Ammonia.—It has been for some time a question whether or not ammonia is the oxide of a metal presumed to consist of H_4N. The strongest argument in favour of its metallic nature has been founded on the fact that an amalgam of mercury may be obtained by means of ammonia. The argument derived from this has, however, been rendered extremely doubtful by the researches of Dr. C. M. Wetherill. The so-called ammonia amalgam possesses physical properties exactly similar to those of the other amalgams; but they are found accompanied by one of a suspicious character—the mass gradually shrinks *of itself*, and becomes resolved into ammonia and mercury. It appears certain, from the experiments of Dr. Wetherill, that the so-called amalgam is merely a mixture of ammonia, sodium amalgam, and mercury, swollen up by the bubbles of hydrogen set free during the process used in forming it, and retained by some of the sodium amalgam used as a medium from the production of the amalgam of ammonia. The sodium is thus kept out of contact with the solution of ammonia salt; but it becomes gradually oxidized, and the swelling subsides. That such is the nature of the product obtained appears certain; since the hydrogen to

which the effect is due has been actually obtained. Mere compression, by squeezing out this gas, destroys the amalgam, leaving a film which has the appearance of lace, on account of the space which the bubbles of hydrogen had occupied; and finally the formation of the amalgam depends on its capability of being swollen up by the gas, since the more fluid the sodium amalgam the more effective it is in producing the supposed amalgam of ammonia. The question regarding the nature of ammonia is more important even than, at first sight, it would seem; since, if ammonia is the oxide of a metal, we may fairly conclude that many other of the metals, if not all of them, are compound bodies; and if they are compound, it must be possible to form them artificially; in which case the alchemists were not the visionaries they have so long and generally been considered.

Economic Productions of Pyrogallic Acid.—In practice only twenty-five per cent., or one third of what might be expected from theory, of pyrogallic acid is obtained from gallic acid. This loss, from the imperfection of the process employed, is very serious, as the quantity of pyrogallic acid now used, especially by photographers, is great. Attempts were made by various chemists of great eminence to prevent this waste, but with only partial success, until M.M. Victor de Luynes and G. Esperandieu devised the improvements, which they have recently brought under the notice of the Academy of Sciences. The waste which occurs with the ordinary process arises—as it often does in similar cases—from decomposition occurring at the very temperature required for production, and is therefore proportional in amount to the time required for the manipulation. It is avoided by the method of M.M. de Luynes and Esperandieu, who decompose the gallic acid, by subjecting it to the action of bases, or even of pure water, in close vessels. They introduce the gallic acid, along with two or three times its weight of water, into a bronze boiler, and heat it to between 200° and 210° Cent. Having kept it at this temperature for about half an hour, they allow it to cool; then boil the resulting pyrogallic acid, which is almost colourless already, with animal charcoal, filter, and evaporate at an open fire, to drive away the water. On cooling, amber or rose-coloured crystals are formed—they would be white if the distillation had been effected *in vacuo*. The quantity of pyrogallic acid obtained in this way is fully equal to that which theory would lead us to expect; and the quality is quite as good as that ordinarily obtained by sublimation. This method was first used by Pelouze, but was not, until now, applied to commercial purposes.

Light as a Source of Motion.—Although it has been known for some time past that light is capable of producing mechanical effect, the amount of this effect was unknown; it has, however, been determined by Professor Thomson of Copenhagen, by changing the light into heat, the mechanical effect of which is easily calculated. To free the beam of light, which he examines, from all calorific rays, he passes it through a layer of water; and, when it is afterwards transmitted to the thermo pile, the deflections of the needle accurately indicate its heating power. During these experiments certain dis-

turbing circumstances came into operation, but their influence was calculated and allowed for. Thus the water absorbed, not only the calorific, but 0·13 of the luminous rays also; six sevenths of the radiant heat and light of a flame are carried away by the heated air —the amount being modified, however, by the intensity of the heat and light. Light obtained from various artificial sources was used; and it was found that a flame, the intensity of which is equal to that of a candle which burns 8·2 grammes of spermaceti per hour, radiates per minute, light which, if changed into heat, would raise the temperature of 4·1 grammes water, one degree Cent. It has been calculated, from the results afforded by these experiments, that the light emitted by the sun would lift thirty-five billions of tons one billion of kilometres high per second, and that it would raise the earth twenty feet in the same time.

Ferrosum and Ferricum.—The striking difference between the salts of the protoxide and those of the peroxide of iron has always attracted the attention of chemists; but, until recently, it was not suspected that they were in reality salts of metals which, except that they are capable of being converted into each other, are as different as they could be. Berzelius first ascertained their separate existence: he termed that found in the protosalts *ferrosum*, that found in the persalts *ferricum*. These allotropic states of iron are as different in their properties as the two varieties of phosphorus, or those of sulphur. Their atomic weights are not the same; that of ferrosum being 28, and that of ferricum 56. The one combines with a single atom of oxygen, the other with not less than three. Hitherto only ferrosum had been obtained. M. de Cezancourt has demonstrated the existence of ferricum in the metallic state; and during his researches on the subject has discovered facts which may have a serious influence on the iron manufacture. Before he proved the contrary, it was believed that cast iron, steel, and wrought iron, differed only in the quantity of combined carbon: although it had been observed that their properties were not always in accordance with their constitution. Specimens of cast iron of the very same composition are often very dissimilar in quality and appearance; cast iron and steel sometimes contain the same elements in the same proportions; specimens of steel and malleable iron are found occasionally, of the very same composition. M. de Cezancourt has ascertained that, in reality, the difference is due to the degree of oxidation in which the iron exists in the ore. The salts of the protoxide furnish one kind of iron, and those of the peroxide another. Different ores will furnish different kinds of iron or steel, according as they contain ferrosum or ferricum, or both. Malleable iron contains a mixture of ferrosum and ferricum, the ferrosum being changed by a high temperature into ferricum: and its quality is dependent on their relative amounts. Steel, if stable, and of a good kind, contains ferrosum and ferricum in the proportion of their atomic weights; and hence magnetic oxide of iron will afford excellent steel. In black and grey cast irons, the ferricum has abandoned, while cooling, the charcoal it dissolved at a high temperature; ferricum generally predominating in the grey.

In mottled cast iron, the ferrosum and ferricum retain their peculiarities; the white portions being formed by ferrosum in combination with carbon, and the dark by ferricum with its deposit of carbon. White crystallized cast iron consists of ferrosum in combination with carbon. Ferrosum is characterised by being obtained at very low temperature, and, when combined with carbon, is hard and brittle. The characteristics of ferricum are its abandonment of carbon, during slow cooling, and its malleability. It cannot by itself form stable steel; it requires for this purpose to be mixed with ferrosum, which passes into the state of ferricum without losing its hardness. Ferricum, unless it has been originally ferrosum, cannot be changed to it. The nature of the re-agents, and the degree of temperature used in the production of iron, modify the proportions of ferrosum and ferricum in the result. Thus oxide of carbon, which contains only one atom of oxygen, favours the production of ferrosum; bodies which, like phosphorus, combine with some uneven number of atoms of oxygen, not less than three, favour the production of ferricum. A low temperature tends to produce ferrosum, a high one ferricum. To obtain the best commercial iron, the nature of the ore, the re-agents, and the temperature must all harmonize. The employment of suitable re-agents shortens the time during which it is necessary to employ a given temperature, in order to obtain a certain kind of iron. The sudden cooling of steel causes carbon, which slow cooling would separate, to be retained in combination—with the ferrosum permanently, with the ferricum in such a way that subsequent tempering liberates it, and restores malleability. If the relative proportions of ferrosum and ferricum depend on the temperature and re-agents which have been employed in the manufacture, and not on the ore which has been used, they will be more or less unstable; and the quality of the iron will be impaired—slowly by time, and rapidly by repeated vibrations; which explains many causes of the breakage of axles, etc. There is reason to suppose that the calorific capacity of iron depends on the relative amounts of the ferrosum and ferricum which it contains; should such prove to be the case, calorific capacity may afford a simple and reliable test of the quality of iron.

New Galvanic Battery.—It has been found that a battery, the elements of which are silver and magnesium, is far more powerful than one of equal size consisting of copper and zinc. M. Bultinck found that when silver and magnesium, immersed in pure water, caused the galvanometer to be deflected temporally 90°, and permanently 28°, copper and zinc, in the same circumstances, caused a temporary deflection of only 30°, and a permanent one of only 10°. And when silver and magnesium were used, the same result was obtained with pure water, as when a dilute acid or saline solution was employed with copper and zinc.

Graphitic Acid.—This curious compound, which was discovered by Sir B. Brodie, has been recently examined by Dr. Göttschalk, who has discovered its constitution to be $G_{28} H_{4} O_{18}$. It is formed by heating pure graphite several times in succession with chlorate of potash, and the strongest nitric acid. The colour of the graphite

is not changed by the first heating: but the second, and those which follow, cause it to pass through various shades of green, until at length it becomes yellow. The process is then complete, and the graphitic acid obtained must be washed and dried in an exhausted receiver, or at a temperature of 100° Centigrade. It is in the form of very small transparent scales, which darken in the light: and is insoluble, except in water or alcohol, which dissolve only a very small amount of it. It may perhaps be used hereafter in photography, as paper which has been dipped in its aqueous solution becomes brown under the influence of light.

MISCELLANEOUS.—*Action of Light on Sulphuret of Lead.*—It has been observed that lead paint which has been darkened by the sulphuretted hydrogen found in the atmosphere, etc., is completely restored to its original whiteness by the action of light. The bleaching is very rapid if drying oil, and still more so if boiled oil, has been used in the paint. This fact proves how necessary it is that places where pictures are kept should be lightsome.——*Gun-Cotton and the Alkaline Metals.*—Gun-cotton will explode if either sodium or potassium is placed upon it; but not if a mixture of both. The discovery of these facts may perhaps lead to an explanation of the effects which the alkalies are known to produce on collodions.

ARCHÆOLOGIA.

THE fear of the CATTLE PLAGUE has lately so much weighed upon all classes of society, that it seems to have made itself felt even among antiquaries, and the opening meeting of the session of the British Archæological Association, on Wednesday evening, Nov. 22, was occupied by an amusing and interesting paper by the Hon. Secretary of that body, Mr. H. Syer Cuming, "On Charms employed in Cattle Disease." It would be an interesting, and far from an invaluable labour, to trace the history of the murrains, or cattle diseases of former days, and their causes and effects; but Mr. Cuming has treated only upon the means then employed for their cure, which, being the mere results of popular superstition, have, of course, no use in modern science and practice. Nevertheless, they furnish curious illustrations of the state of knowledge and intellectual development in the middle ages. The diseases of cattle were ascribed, by the peasantry in those ages, and even in much more modern times, to two agencies especially—to the malignity of certain classes of evil spirits, and to the influence of the evil eye. In the process of cultivating the ground, he frequently picked up the implements made of stone, which are now the object of so much archæological interest, but the real object of which the mediæval agriculturist could not understand, and he believed them to be ungodly weapons which the evil spirits hurled at his cattle, and which produced the dreaded and ruinous murrain. The fatal in-

fluence of the evil eye was an article of belief from the most remote ages. Superstition offered the preventive or cure, as well as the cause of the evil; and it is on this part of the subject that Mr. Cuming treats, in the paper read before the British Archæological Association. There is a sort of homœopathic feeling which seems to be natural to man in a state of ignorance, which leads him to suppose that a disease produced by such supernatural agencies would be best cured by the application of the instrument which had created it, and at least some forms of these stone implements, and stones of rare character unworked, were preserved carefully for this purpose. These objects were supposed to be the work of the fairies, who had imparted to them magical properties, which might be employed either by touching the diseased cattle, or by washing them with the water in which the magical amulets had been dipped. Mr. Cuming gave numerous anecdotes of this practice. The possession of such amulets was greatly coveted, and they were often set in silver. In Scotland, even so recently as the time of Pennant, that writer tells us that "Capt. Archibald Campbell showed me one —a spheroid set in silver—for the use of which people came above a hundred miles, and brought the water it was to be dipped in with them." These objects were sometimes balls of crystal. One of the most celebrated of these is in the possession of the Marquis of Waterford, and is said by traditionary legend to have been originally brought from the Holy Land. When pestilence appears among the cattle, this amulet is in great request, to be dipped in the water given the cattle to drink, or in a brook, through which they are driven backwards and forwards. Mr. Cuming exhibited several examples and drawings of these amulets, among which the most remarkable was the celebrated *Lee Stone*, or *Lee Penny*, which is said to have suggested to Sir Walter Scott the design of his "Talisman." According to the legend, Robert Bruce wished that, after his death, his heart should be carried to the Holy Land by Sir James Douglas, and in 1329, the latter, accompanied by Sir Simon Locard, of Lee, proceeded on the mission. In Spain, the Scots were drawn into a combat with the Moors, Douglas was killed, and Sir Simon, who now commanded the party, turned homeward with Bruce's heart, which was eventually buried in the abbey of Dunfermline. Sir Simon had taken prisoner a Moorish chieftain; and the wife of the prisoner, when she bargained for her husband's ransom, counting the gold from her purse, let drop this gem, and appeared so anxious to recover it, that Locard insisted on its being made a part of the ransom. The lady unwillingly consented, and informed the greedy Scot that its value consisted in its power in healing diseased cattle, and that it was also a sovereign remedy against the bite of a mad dog. So great was the popular faith in this "talisman" in Scotland, that the Lee Penny was excepted from anathema in the clerical war upon superstitions, after the Reformation; and the clergy went so far as to extol its virtues, which were resorted to for the cure of infected cattle until a very recent period. The Lee Stone appears to be the variety of cornelian agate called *hæmachates*—a heart-shaped pebble, measuring about half an inch

each way, set in a silver coin about an inch in diameter. There appears to be some doubt as to the character of the coin, but it is believed to be the Scottish groat, a coin which first appeared in Scotland under King David II. (1342—1371). The margin of the Lee Penny is pierced for the insertion of a silver chain, at the end of which is a ring, for the convenience of dipping it into the water to be administered to the cattle. Mr. Cuming, in the sequel of his paper, spoke of other charms employed against the cattle disease, which are so many proofs of the extent of the alarm to which it gave rise in former days.

On the same occasion, Mr. Kell laid before the meeting a collection of COINS, chiefly Roman, and a few other objects of antiquity, found in the ISLE OF WIGHT. The coins, as usual, ran through the Roman period, and the only remarkable circumstance connected with them is that there were among them a certain number of Greek coins. This circumstance is supposed, by a train of reasonings which we do not clearly understand, to be connected with the supposed line of transit of the early tin trade through the Isle of Wight. Greek coins have previously been found among Roman remains in this country, chiefly in the southern parts of the island and at Exeter, and there is no reason whatever why this should not be the case. Many Greek subjects of the Roman Empire were no doubt in this island, some of them, perhaps, merchants from the islands of the Archipelago and the Eastern Provinces, and the coins found here are such as were in circulation during the Empire. If any coins had been left here at the period of the tin trade, by way of "Icbis," as described by Diodorus Siculus, they would have been, in all probability, not pure Greek, but imitation Greek, that is Gaulish. Among the other objects exhibited was a diminutive, but very elegant, bronze figure of Mercury. The discovery of late years of so many Roman antiquities in the Isle of Wight, shows that that island was largely occupied by the Romans, a fact which we had a right undoubtedly to expect, and probably the principal Roman establishment there lay at Newport and in the immediate neighbourhood. When the Saxons seized upon the island, they also appear to have made this spot their head-quarters, and they gave it, from their chieftain, the name of Wihtgara-burk, from which the modern name of Carisbrook is supposed to be derived. However, the traces of Roman settlement had probably disappeared aboveground during the Saxon period, for the very names of the two towns which appear to occupy Roman sites, Newport and Newtown, where Roman antiquities have also been found, are evidence that when they were founded there were no existing towns there. These names are very significant, and belong to the feudal period. The feudal barons soon began to learn that the regular tribute derived from a corporation of free-traders placed under their protection, was far more advantageous to them than the irregular and violent contributions which they could levy upon traders who passed through their territory, and would of course on that account seek to evade it. They, therefore, sought to draw into their territory commercial settlers, by offering them a place to establish themselves, with the assurance of

freedom of trade and protection. The formation of such towns belong chiefly to the twelfth and thirteenth centuries, and they were called, in the French language of feudalism, *franchevilles* and *neuvevilles*, and in England *Newports*, or *Newtowns*, or, more early, *free-towns*. Newport and Newtown were both foundations of this description—*port*, in Anglo-Saxon, meaning a town which enjoyed certain free institutions.

Among the antiquities from the Isle of Wight were a few of the curious LEADEN SEALS, or stamps, of which we have spoken on a former occasion, and which have been found in larger quantities, and with more unmistakable Roman character, on the Roman site at Burgh-under-Stanemore, or Brough, in Westmoreland. At the last meeting of the Archæological Institute, a Polish antiquary, Count Tyszkievicz, communicated an account of similar leaden seals found at some distance from Warsaw, which were ascribed by the antiquaries of Wilna to a Slavonic race formerly inhabiting that district. There can be little doubt, however, that, as Mr. Albert Way stated before the Institute, they belong to the Roman period, and are, as he then suggested, curious monuments of Roman commerce. The Count with the difficult name believed them to have been of a religious character. The discovery of these leaden stamps in such numbers in the Isle of Wight may fairly be considered as evidence that that island was, in Roman times, a place of some commercial importance; but there is a difficulty in this case arising from the circumstance that, unlike the discoveries at Brough-under-Stanemore (the Roman *Verteræ*), the Roman leaden stamps found in the Isle of Wight have become, accidentally, mixed with somewhat similar objects belonging to the Middle Ages, and even to very recent times. This has led to some confusion, and it is to be hoped that, in future, antiquaries and collectors will be very careful in ascertaining minutely the exact circumstances of their discovery.

The Sunderland papers of the latter days of the month of September speak of the discovery of a remarkable BONE-CAVE at the Ryhope Colliery, by the workmen engaged in quarrying in the limestone rock. The rock was blasted, and in removing the loosened fragments of rock they came upon a large quantity of bones, including several human skulls, numerous skulls of other animals, such as foxes, badgers, etc., and a great quantity of human and other bones. The place where the bones were found was about twenty feet below the surface, and about thirty feet within the bank. The appearance indicated that there had been a cavity in the rock which had at one time been filled with water; but there appears no means of accounting for the presence of the skulls and bones, except that they were washed into the hollow of the rock many centuries ago. Three of the human skulls, one of which was remarkably perfect, having most of the teeth in, with several other human bones, were taken care of by the resident engineer of the colliery, but a large mass of other bones were allowed to be carried away.

T. W.

LITERARY NOTICES.

A Dictionary of Science, Literature, and Art. Edited by W. T. Brande, D.C.L., F.R.S.L. and E., of Her Majesty's Mint, and the Rev. George W. Cox, M.A., Lat. Scholar of Trinity College, Oxford, assisted by gentlemen of eminent scientific acquirements. Parts VI. and VII. (Longmans.)—We have on former occasions expressed a general good opinion of this work, and when compelled to make some observations of a contrary description, our objections and remonstrances referred to the department ostensibly under the care of Professor Owen, whose name figures amongst the list of contributors as responsible for articles on "Biological Sciences, comprising Anatomy, Physiology, Zoology, and Palæontology." No one can suppose for a moment that Messrs. Longman would make such use of Professor Owen's name unless they had made arrangements with him by which the purchasers of the new edition of Brande's Dictionary would be entitled to the benefit of his services. It is true that Mr. Carter Blake is associated with him, but it is Professor Owen's name that is expected to win confidence for the papers relating to the subjects which he nominally superintends. In the present number, we can repeat our general commendation of the labours of the various contributors, but the department assigned to Professor Owen is simply disgraceful. We turn, for example, to the article "Infusoria," and we find the subject dealt with in something less than two columns of antiquated rubbish. We are very sorry to feel compelled to speak thus of anything going forth under the learned Professor's sanction, but it would be dishonest to conceal the truth. We are told in this article that Linnæus placed the Infusoria "at the end of his class Vermes, in a genus which he denominated '*chaos*,'" and in chaos Professor Owen is contented to leave them. Cuvier, he informs us, separated the Rotifera from the Infusoria, and "attributed to them a mouth, a stomach, an intestine," etc. "The anterior lobated organ, and its vibratory *denticulations*," are said to form the main external characteristics. Ehrenberg is then said to have brought to light additional organs in these creatures by the application of a microscope superior to that of his predecessors; and this is about all the information that is given. Thus a reader, not possessing more knowledge of the subject than the learned Professor has thought proper to display, would suppose that nothing of consequence had been discovered since Cuvier "attributed" a mouth, etc., to the Rotifers, and Ehrenberg "brought to light additional complexities." We feel bound to tell Professor Owen that this is not dealing fairly with the public, and we should presume it is not acting up to the requisitions of Messrs. Longman. "The second order of Infusoria in Cuvier's system is then introduced to us, and Ehrenberg's polygastric theory, exploded long ago, is once more affirmed; and in a subsequent paragraph the diatoms are actually called *Polygastric Infusoria*, thus repeating a very pardonable error of Ehrenberg at an early stage of inquiry, but what is now a disgraceful blunder for any naturalist to make. We then

turn to "Intestinal Worms," and find an article that might have been written twenty or thirty years ago, before the structure or history of these creatures was understood. This is the more discreditable, since the publication of Dr. Cobbold's *Entozoa* has placed a large body of accurate information within easy reach. The relation of the hydatids to the tape-worms is not explained, and barely alluded to. This article is perfectly useless to any student at the present day. We must carefully guard against condemning the whole work because Professor Owen's part is badly done. Unless he takes reasonable pains to bring the remainder of his papers down to within a few years of the present date, the student may save himself trouble by considering the "biological sciences" omitted from this edition. In other departments, he has a good chance of getting the information which he wants, though now and then a slip is made. Thus the writer of "Irradiation" misquotes the old ballad of "Sir Patrick Spence," and explains what he calls the "*new* moon in the old moon's arms" as an effect of irradiation!

Diarrhœa and Cholera; their Origin, Proximate Cause, and Cure, through the Agency of the Nervous Centres, by means of Ice. By John Chapman, M.D., M.R.C.P., M.R.C.S. (Trübner & Co.) —Dr. Chapman considers summer diarrhœa and cholera to result from over-stimulation of the vaso-motor centres by the heat of hot climates or the summer of temperate climates. This excitation of vaso-motive action induces contraction of the blood-vessels supplying the intestines, and at the same time stimulates the mucous glands. Ice reduces vaso-motor energy, and removes the diseases. This is Dr. Chapman's argument, ingeniously supported by reasoning, and by an appeal to cases. If this is a true explanation of cholera, how does it account for the winter attacks of that malady, which, if we remember right, were very violent some years ago, both in Russia and Scotland? Dr. Chapman stands out favourably from the ordinary run of doctors by having a philosophy, and by having arrived at it through a process of reasoning upon physiological facts. Whether he is right or wrong, numerous experiments must show. He is an independent thinker, and having studied medicine somewhat late in life, he was probably less amenable to the baneful influences in favour of mere orthodoxy and receptivity which medical schools appear to exert on ordinary pupils.

Elements of Physics and Natural Philosophy. Written for General Use in Non-technical Language. By Neil Arnott, M.D. Sixth and Completed Edition. Part II. (Longmans.)—This second part and volume of Dr. Arnott's great popular work treats of heat, light, electricity, magnetism, and astronomy; and in an appendix we find a brief treatise on popular geometry, which might be advantageously extended and published in a separate form. We cannot say that the second volume of the "Elements of Physics" is as good as the first, though it contains much valuable matter admirably put. The portion relating to heat was written before heat was generally considered as a mode of motion; and although modern ideas and discoveries are slightly noticed, they do not occupy the position to which they are fairly entitled. From section 115,

the reader would imagine that a spherical mirror brings parallel rays to one focus. If this were the case, opticians need not trouble themselves to give telescope mirrors a parabolic form. We should have expected Dr. Arnott to give a popular explanation of polarized light, but this subject is passed to "persons who have leisure." We presume this means that the learned doctor had not leisure enough to complete his task.

PHILOCALIA: Elementary Essays on Natural Poetry and Picturesque Beauty. By WILLIAM PURTON, M.A. (Shrimpton, Oxford; Whittaker & Co., London.)—The object of this work seems to be a defence of Aristotle's thesis that poetry is imitation. We do not see that Mr. Purton throws any new light upon the matter.

THE RECORD OF ZOOLOGICAL LITERATURE, 1864. Volume I. Edited by ALBERT C. L. G. GUNTHER, M.A., M.D., Ph.D., F.Z.S., etc., etc. (Van Voorst.)—The object of this book is the praiseworthy one of providing a catalogue *raisonné* of the zoological publications and information of the year. It is not likely that the first volume of such a difficult undertaking should be all that could be desired, but much has been accomplished, and students of natural history will be glad to know that a beginning has been made. Such a work ought to find its place in our chief public libraries.

A DESCRIPTIVE CATALOGUE OF ALL THE GENERA AND SPECIES CONTAINED IN THE ACCOMPANYING CHART OF CRUSTACEA. Showing the Range in Time of the Several Orders, with some Recent Types. Illustrated by upwards of 490 figures, arranged and drawn by J. W. SALTER, A.L.S., F.G.S., and HENRY WOODWARD, F.G.S., F.Z.S., engraved on steel by J. W. LOWRY, F.R.G.S. (Tennant, Strand; Lowry, Robert Street, Hampstead Road.)—We do not remember to have seen any chart of the kind so well arranged, both for reference to the figures, and the explanatory text. The latter occupies a series of pages on the left-hand side of this handsome, double volume, while the chart unfolds to the right. The figures are beautifully engraved, and the work deserves a hearty welcome from geologists and other cultivators of natural history. The various genera and species of crustacea are grouped together, so as to show the geological period in which they are first known to have occurred, and the extent of their persistence in geological time. Figures of modern species are likewise given to a sufficient extent to indicate the changes that have taken place in the crustacean world. Thus, in addition to the value of the chart for the identification of fossils, it conveys a large and valuable amount of really scientific information, compressed into a very convenient and advantageous form. It is very seldom that work of this kind is so judiciously and carefully done.

BRITISH ASSOCIATION CHARTS FOR OBSERVATIONS OF LUMINOUS METEORS. Printed for the British Association Luminous Meteor Committee.—Under this title a series of star-charts, forming a celestial atlas of fourteen plates, was laid before the meeting of the British Association at Birmingham by Mr. Glaisher. The atlas is

intended, according to Mr. Glaisher's report, to enable observers of shooting stars to record their observations in an exact and systematic form. The object of providing star-charts for meteor observations engaged at a very early date the attention of the distinguished astronomer, Bessel, who, in a long and elaborate article on shooting stars contained in the *Astronomische Nachrichten*, vol. xvi., p. 347, thus describes his own experience:—"The course of phenomena so fugitive as shooting stars, too swift to be followed with our instruments, can only be noted and drawn exactly among the stars of an ordinary star-map by hand and by careful watching. Such maps I have always found very inadequate for the purpose, partly because they represent only a small portion of the visible heavens, and partly because they are rendered indistinct for the most part by the images of the constellations drawn upon them. The net or web of these maps is also seldom engraved so close as to allow positions on the maps to be read off to a part of a degree." Regarding these objections as fatal to the use of ordinary star-maps, Bessel devised a new atlas, to be constructed especially for observations of meteors. The project was carried out, and the atlas was completed by G. Schwincke, of Pillau, and published at Leipsic in 1843. It consists of five stereographic charts, 18½ Prussian inches long, and 16½ wide, representing the visible heavens at Konigsberg, as far as the thirtieth parallel of S. declination, and containing one chart for the North Pole, and four for the region of the equator. Adopting identically the same plan of arrangement, and projecting the sphere upon its circumscribing cube, the late Sir John Lubbock had previously figured the whole visible vault of the heavens upon an atlas of six maps, containing four maps for the equator, and one for either pole. These maps, published in 1836 by the Useful Knowledge Society, owing to their remarkably simple mode of projection, are better fitted for recording shooting stars than those afterwards produced by Bessel. Following the example set before them by Sir John Lubbock in the maps of the Useful Knowledge Society, the Committee of the British Association last year undertook to prepare the present series of star-maps, on the principles of plane perspective projection. As the result of their exertions during the year, Mr. Glaisher presented to the British Association fifty lithographic copies of the complete set of maps. Each map represents the sky as it might be imagined to appear at Greenwich, traced through on a flat transparent ceiling, placed four inches above the eye of the spectator. A single map of the series, twenty-two inches long and eighteen inches wide, includes the whole visible heavens at Greenwich, to within 25° from the horizon on either side, to within 20° degrees at the ends, and to within 16° at the corners of the map. Since the heavens revolve, twelve maps in succession are made to represent, in order, the appearance of the sky at intervals of every two hours throughout the twenty-four, or, according to another commodious form of their adaptation, from month to month throughout the year. The set is numbered and named, from No. 1, January, to No. 12, December, according to the month, in which each map represents faithfully the appearance of the sky at

about ten or eleven o'clock at night. The whole series exhibits a complete cycle of the stars of the constellations of Bode. The net or web on which the maps are constructed, showing, for the entire circumference, and to nearly 15° below the equator, every individual degree of both Right Ascension and Declination was ascertained by Dr. Heis, of Munster, to be correct to a small fraction of a degree. It forms a separate plate in the atlas, so as not to interfere with the distinctness of the other maps. A net of circles of altitude and azimuth is also added, the whole together forming an index of the completest kind for observing and mapping shooting stars. To illustrate by an example the characteristic features of the maps, the branching wings of *Cygnus*, in whatever map of the series they appear, point infallibly to the last star of the tail of *Ursa Major:* and the brightest stars of *Draco* are found, as they are in the sky, in a direct line between these two distant points. The beginning and ends of a meteor's course being noted upon one of the maps, and these two points being joined, the straight line between them, however distant they may be, represents the meteor's course across the sky, from its point of appearance to its disappearance among the stars. Dr. Denison Olmstead, it is well known, explained the existence of the radiant point of meteors, by stating it to be the vanishing point of their straight courses seen in perspective. It happens not unfrequently that the tracks of twenty or thirty meteors, seen on a single night, prolonged backwards upon the maps, are found to intersect each other in a single point. Such a circumstance, where it occurs, cannot be purely accidental; but, on the contrary, it amounts to a positive proof that the point in question is the vanishing point of a series of parallel flights, which together compose a true meteoric shower. The point determined in this manner is the radiant point, whose position determines the axis of the shower, or the general direction of the meteors. Radiant points determined by means of these maps are described in the *Monthly Notices* of the Royal Astronomical Society for Dec. 9, 1864, and March 10, 1865. They have reappeared in the present year, as described at a recent meeting of the Astronomical Society, in such a manner as to show that the dates of meteoric showers, and the positions of their attendant radiant points, are singularly fixed and permanent, and that the meteoric showers themselves, however startling the conclusion may appear to our readers unaccustomed to speculate in astronomy, are a collection of small planetary or cometary bodies coming into direct collision with the earth. The new charts are the work of Mr. Alexander Herschel, to whom this branch of astronomy is, in many other respects, deeply indebted.

SEVEN LECTURES ON SCRIPTURE AND SCIENCE. By JOHN ELIOT HOWARD, F.L.S., etc. (Groombridge & Sons.)—We can only state the contents and nature of this work, as a review of its opinions would carry us beyond our boundaries into the regions of critical and polemical theology. The subjects treated by Mr. Howard are—"The Scriptures viewed as the Oracles of God," "The Books of the Old Testament and their Authorship," "The New Testament, its Authority and Authorship," "Colenso and his Diffi-

culties," "The Six Days of Creation, as given in the Book of Genesis," "The Laws of Nature and Miracles," and "Mysticism as Opposed to the Revelation of God in Scripture." Mr. Howard, though claiming to stand alone as an independent thinker, in the main finds himself in agreement with those who hold what are called orthodox opinions in theology, and who reject all the conclusions of the school of criticism to which Bishop Colenso is attached. The titles of Mr. Howard's chapters, as an indication of his tendencies, will suffice to attract the attention of readers likely to sympathise with his endeavours.

The Astronomical Register. (J. D. Potter, Poultry.)—We are glad to see from the names of subscribers and the character of its correspondence that this monthly periodical is appreciated by many of our best working astronomers. We observe that it frequently renders good service, which only a work devoted to a single subject could undertake.

The Geological Magazine. Edited by Henry Woodward, F.G.S., F.Z.S., of the British Museum, assisted by Professor John Morris, F.G.S., etc., and Robert Etheridge, F.R.S.E., F.G.S., etc. (Longmans.)—This work, in which the defunct *Geologist* has been incorporated, is now in able hands, and supplies a valuable record of facts, many of which could only be collected in a periodical devoted to a single science.

Winter in the South of France; or, Mentone, the Riviera, Corsica, Sicily, and Biarritz, as Winter Climates. By J. Henry Bennett, M.D., etc., etc. Third Edition. (Churchill.)—Dr. Bennett has greatly enlarged this work, rendering it exceedingly interesting as a book of European travel, and a valuable guide for invalids seeking a suitable winter residence. It is elegantly got up, with a fine view of Mentone, and other excellent illustrations. Dr. Bennett has tried the climate of Mentone, or Menton, as its French possessors now call it, for six winters, and both in his own person, and in the experience of patients whose cases he has watched, it seems to have been demonstrated that it possesses an invaluable influence in curable forms and stages of consumption. The book abounds in very pleasantly given scientific information, and it is evident that the doctor has a keen eye for objects of natural history, as well as for picturesque scenery, and for those possibilities of comfort without which no invalid should leave his own home.

Dr. Bennett enters into the physical geography of the Mediterranean coast of France and Italy, and shows how the mountains hook round Mentone, shielding it from north and north-easterly winds, and leaving it open to mild breezes and sunny influences. It is from this peculiarity of situation that, although cooler and drier than Madeira in the winter, it is yet much warmer than most other places of similar latitude. Lemons grow there to great perfection, and the olive trees are remarkable for their luxuriance. Dr. Bennett says, "The longevity of the olive-tree in a congenial climate like that of Mentone may indeed be said to be indefinite. There are olive-trees still alive at Monaco, at the Cap Marten, and elsewhere, which are supposed to be coeval with the Roman empire.

It is a slow growing tree, and forms cart-loads of hard roots, which fill and cover the ground where it stands. When, after several hundred years, the trunk decays, the bark still remains alive. As the decay progresses, the tree splits, as it were, into two, three, or more sections. The bark twists and curls round each of these decayed sections, and unites on the other side. Thus, instead of the old tree, we have in its place two, three, or more, apparently separate, although in reality all growing from the same root. When these in turn die, new shoots spring up from the old roots, and thus the life of the tree is indefinitely prolonged." Dr. Bennett gives an interesting plate of grand old trees formed upon this plan. We hope his book will help to convert invalids into observers of natural objects. The want of mental occupation is a powerful hindrance to the comfort, and often to the cure of persons driven from their homes in search of health.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

LIVERPOOL PHILOSOPHICAL SOCIETY.

VENTILATION OF SEWERS.—At the last meeting of this society, Mr. Higginson drew attention to the extract from the *Scientific Review* on the ventilation of sewers, stating that a French chemist had proposed to draw from the sewers a supply of air for the support of the combustion of furnaces in factories, thus destroying the noxious gases by combustion, and supplying fresh air to the sewers. It was stated that the plan was already in use on a small scale. Mr. Higginson stated that he had suggested the same plan to the Social Science Association at Liverpool in 1858.

The advocates of this mode of ventilating sewers seem to be unaware of a fatal objection to its employment, namely, that the gases given out by the decomposing sewage consist chiefly of carburetted and sulphuretted hydrogen, that these are combustible, and capable of forming an explosive mixture with atmospheric air.

The plan was tried in London many years since, during one of the earlier outbreaks of cholera, and a very serious explosion took place in the sewers of the neighbourhood in consequence. As it is impossible to prevent such a result from recurring, or to predict the extent of damage that might ensue, the proposal cannot be regarded as safe.

CHEMICAL SOCIETY.—*Nov.* 2.

DISCOVERY OF CERIUM IN ENGLAND.—Professor A. Church exhibited several new minerals which had been recently discovered in Cornwall. The most interesting of these was a hydrated phosphate

of cerium, and it was important as furnishing the only instance of the occurrence of the rare metal cerium in Great Britain. The other new minerals described were a hydrated phosphate of aluminium and calcium, and a hydrated arseniate of copper and lead.

A communication was also made by Mr. John Hunter on the absorption of vapours by the charcoal obtained from the shell of the cocoa-nut. This possesses a high degree of absorbing power; taking up at the elevated temperature of 90° Cent. no less than 155 times its bulk of the vapours of methylic alcohol.

THE ENTOMOLOGICAL SOCIETY.—*Nov.* 6.

Acclimatization of British Insects in Canada.—Mr. G. J. Bowles communicated a paper on the recent naturalization and rapid spread of the small white cabbage butterfly, *Pieris Rapæ*, in Canada. It is presumed that the insect must have been imported in the condition of eggs or pupæ. For some seasons only a few specimens were seen; but recently the increase of their numbers has been very great. As the *Pieris Rapæ* feeds on a vast number of plants, although selecting in preference those belonging to the cruciferous group, there can be no doubt that it will become a permanent addition to the fauna of the North American continent.

GEOLOGICAL SOCIETY.—*Nov.* 8.

"On the Origin of the Parallel Roads of Glen Roy."—The Rev. R. Boog Watson gave a brief description of these well-known "Roads," in which he analysed the two principal theories that have been started to account for their formation—namely, the Ice-dam theory and the Marine theory. With regard to the first theory, he stated his opinion that although it has some strong points, especially in respect of the coincidence between the levels of the "Cols" at the glen-heads, and those of the "Roads," yet on the other hand it is weak, inasmuch as the cause assigned is extremely local in its action, while the phenomena to be explained are very general and have a wide range—terraces similar to those of Glen Roy occurring in Scandinavia and elsewhere. In the author's opinion, the formation of the "Roads" by an ice-dam is impossible, for the dam would not have been water-tight, and there is no period at which it could have existed during the post-Pliocene changes in Scotland. Objections like these cannot be urged against the Marine theory, as the sea has been on the spot, and is able to perform the work required of it. At the same time the author admitted that the Marine theory is not free from difficulties, the chief being the perfection and horizontality of the "Roads," and their barrenness in Marine organisms.

MICROSCOPICAL SOCIETY.—*Nov.* 8.

THE VEGETABLE PARASITES OF THE HUMAN SKIN.—Mr. Jabez Hogg read a valuable paper on this subject, the object of which was to show that vegetable parasites do not produce the different varieties of skin disease; but that when certain diseases already exist, that the fungi, finding a suitable soil, greatly aggravate and often change the type of disease; that these diseases are always associated with neglect of person, dirt, bad air, want of light, and deficient nourishment; that the spores of fungi are always floating about in the atmosphere, and are thus ever ready to be deposited and take root in a favourable soil; of this Mr. Hogg gave many illustrations, and showed that although yeast, *penicillium*, *aspergillus*, and some other well-known fungi, had been separately classed, that nevertheless they could be made to pass through the same changes, and produce ferments that could not be recognised one from the other; and, therefore, difference of form he believed to be entirely due to the soil or nourishment supplied, and dependent on such circumstances as whether the growth of the fungi takes place in a sickly plant, a saccharine solution, or an animal tissue.

ROYAL GEOGRAPHICAL SOCIETY.—*Nov.* 13.

THE DISCOVERY OF LAKE ALBERT NYANZA.—Mr. S. W. Baker read a paper descriptive of the discovery of this lake. In December, 1862, he started up the Nile from Khartoum with a powerful force, including many camels, horses, and asses. Pursuing his course, he entered upon a dreary waste of water, where he soon lost his only European attendant. The remainder of the party safely reached Gondokoro, where they awaited a trading company, travelling southwards. Gondokoro itself was a wretched place, being occupied only occasionally by traders. After a stay of fifteen days, Captains Speke and Grant arrived, clothed in humble rags, but with the glory of success upon them. Captain Speke told him that he was assured by the natives that a large lake existed to the westward, which he believed would be found to be a second source of the Nile, and that he himself had traced the river up to 2° 20′ N., when it diverged to the west, and he was obliged to leave it. Accordingly he (Mr. Baker) undertook to follow up the stream. The trade along the White Nile really consisted of cattle-stealing, slave-catching, and murder, and the men whom he was obliged to engage at Khartoum were the vilest characters. After Speke and Grant had left him, his men mutinied, threatened to fire upon him, and the Turkish traders whom he intended to accompany set off without him. By means of diplomacy he managed to get back the arms from the recalcitrants, and induced seventeen of the men to go with him to the eastward. He afterwards discovered that they intended to desert him and to join the traders. He followed the trading party who had threatened to attack him, and upon the suggestion of Mrs. Baker, the chief was brought over, and on the 17th of March they safely arrived in the Latooka country,

110 miles east of Gondokoro. That country produced ample supplies of grain and supported large herds. The towns are thickly populated, and the inhabitants are a warlike but friendly race, who go naked, and train their hair into a kind of natural helmet. The bodies of those who are killed in fight are not buried, but those who die naturally are interred in front of the houses in which they had dwelt, and at the expiration of a fortnight are exhumed, the flesh removed, and the bones put in earthen pots, which are placed at the entrance of the towns. From Latooka he proceeded to Kamrasi's country, across an elevated region, the watershed of the Sobat and White Nile rivers. From the ridge he descended into the valley of the Asua, which river Captain Burton regarded as the main stream of the White Nile, but which, when Mr. Baker crossed it in January, did not contain enough water to cover his boots. He crossed Karuma Falls in the same boat which had carried Captain Speke, but he was detained for some days by the disinclination of the King Kamrasi to allow strangers to pass over. From Karuma Falls the Nile flows due west, a rapid stream, bordered with fine trees. King Kamrasi, was very suspicious, and sought to prevent Mr. Baker continuing his journey, by representing that the great lake was six months' journey—a statement which he received as a fatal blow to all his hopes. Learning, however, from a native that the lake could be reached in something like ten days, he induced Kamrasi, by presents, to allow them to depart. In crossing the Karan river on the way to the lake, Mrs. Baker was struck down by a sunstroke, and remained almost insensible for seven days, during which time the rain poured down in torrents.

On the eighteenth day after leaving Kamrasi they came in sight of the looked-for lake, a limitless sheet of blue water sunk low in a vast depression of the country, surrounded by cliffs, 1,500 feet in height. The western shore, sixty miles distant, consisted of ranges of mountains 7,000 feet in height. Mr. Baker named the lake, Albert Nyanza. That lake, together with the Victoria Nyanza, may be regarded as the great reservoirs of the Nile, which issued from the lake precisely as the natives had reported to Speke and Grant, and from its exit the river is navigable as far as the narrows near the junction of the Asua. Mr. Baker's progress up the Upper or Karuma river was stopped, at fifteen miles distant, by a grand waterfall, which had been named Murchison Falls. Upon their return to Kamrasi's country the travellers were detained nearly twelve months, the King being so impressed with the knowledge of his European visitors that he would not let them leave him. Ultimately the travellers managed to get free, and arrived safely at Alexandria.

NOTES AND MEMORANDA.

Note on Nitride of Iron.—It is an ammonium (NFe_4) in which iron takes the place of hydrogen (see Poggendorf's *Annalen*, May, 1865), and is obtained by heating iron in ammoniacal gas; or, better still—as mentioned in the Int. Obs., p. 311—by passing ammonia over pure protochloride of iron; the reactions being $NH_4O + 4 Fe Cl = NFe_4 + 4 HCl + O$. The hydrochloric acid thus produced unites with some of the ammonia, forming chloride of ammonium, which escapes. But, with regard to the oxygen, it is most probable that, in certain cases, it forms NFe_4O, the analogy with ammonium being thus kept up; that in others it passes off with the chloride of ammonium; and that in others it unites with hydrogen, which is set free during the complicated decompositions that occur when nitride of iron is formed, on account of the nitride being decomposed even by the temperature required for its production, and still more by a higher; nitrides containing varying quantities of nitrogen, and mixtures containing varying quantities of nitride and metallic iron being formed. These mixtures, before the researches of Stahlschmidt, were erroneously considered to be different nitrides.

Extraordinary Flight of Birds.—A lady, dating from Pont de Briéques, near Boulogne, on the 24th Oct., informs us: "While I write, there comes suddenly a great thick black cloud, accompanied by an extraordinary noise. We are all terrified till we discover the cause. Figure to yourself an innumerable flight of black birds as big as pigeons, and going northwards." Similar flights of birds were seen by M. De la Blanchère in the department of Sarthe, on the 30th Oct. See *Comptes Rendus.*

Lunar Photography.—During the partial eclipse of the moon on the 4th Oct., Mr. De la Rue took a series of seventeen photographs, using Steinheil's 13-inch silvered glass mirror of 10 feet focal length, the action of which he did not find more rapid than that of the speculum metal mirrors of same dimensions and focal length which he had previously employed. This is curious, as the reflective power of the silver film is, according to Sir J. Herschel, to that of the best speculum alloy, as 91 to 67. Mr. De la Rue says—"After contact it was found that while an instantaneous exposure sufficed to give a faint impression of that portion of the lunar disk not obscured by the umbra or penumbra, an exposure of a whole minute failed to bring out the details of the lunar surface covered by the umbra, although its details were plainly perceptible in the telescope. The obscured portion of the moon was moreover perfectly visible without optical aid. Further details will be found in *Monthly Notices* (Supplemental Notice), No. 9.

ζ Herculis.—In *Monthly Notices* (Supplemental Notice), No. 9, Mr. Fletcher states that at present this star is absolutely single with his $9\frac{1}{3}$ inch refractor, and power of 1000. A few years ago he had no difficulty in measuring the distance of the companion star with a 4-inch telescope; and he shews that as the companion is close to its perihelion, the earliest possible observation of its reappearance will be valuable.

New Growing Slide.—Mr. H. L. Smith, of Kenyon College, U.S., has contrived a new growing slide for the microscope. It is composed of two glass plates 3×2 inches, and about 1-25th of an inch thick, separated by strips of the same thickness, and cemented by marine glue. One corner of the upper plate is removed, and a very small hole drilled through the upper plate at one corner of the space, to be covered by a piece of thin glass placed over the object whose growth is to be watched. The slide is filled with water by means of a pipette applied to the open corner, and when the covering glass is placed over the little hole, water slowly oozes through, as it is affected by capillary attraction. By this means an object is kept moist. The cell is said to hold water enough for about three days.—*Annals Nat. Hist.*

Dimorphism in Mites.—M. Claparède stated at the last meeting of the Société Helvetique des Sciences Naturelles that dimorphism is found amongst the

Acari, and he instanced the so-called Hypopus, a supposed species of mite found on field mice, bumble bees, flies, ferns, etc., which he has ascertained to be the male of a much larger acarus. The Hypopus has a carapace like a tortoise, and no mouth, or digestive apparatus. The facts described by M. Claparède resemble those elucidated by Mr. Gosse with respect to the males of the rotifers. M. Claparède frequently found the Hypopus and the female form on the same hyacinth bulbs, and he observed that some larvæ of the same acarus had three pairs of feet, and others that were older, four. From these last he witnessed the development of the Hypopus.

EARLY PUBERTY.—M. Ramon de la Sagra communicates to the French Academy a remarkable case of early puberty in a negress. Before she was three years old she exhibited the development customary in girls of her race at thirteen, and her head, which was well formed, and the expression of her countenance would have looked appropriate if placed on the shoulders of a girl of sixteen. At seven years old her figure was fully developed, and her vivacity, intelligence, and manners corresponded with her appearance. M. de la Sagra was not able to continue his observations, and her subsequent history is not mentioned.

WATER SPOUTS AT ANNONAY.—On the 22nd October a tempest occurred in the valley of the Rhone. Thunder was continuous, accompanied by heavy rain and frequent water-spouts (*trombes*). In the streets of Annonay the floods swept away objects of all kinds, including a waggon containing 2000 quintals of iron. Masses of rock brought down by the floods and hurled along the roads excavated the soil, and left many houses hanging over an abyss. In other places masses of stone were piled up to the height of the first floors, and the town was in darkness, as the gas-pipes were unearthed and broken. In the valley of La Deûme workmen were glad to escape from the sudden deluge by getting through the roofs of the factories. A stone pillar, weighing 7,500 kilogrammes, was carried away, together with another object weighing 1500 kilogrammes. The water rose about twenty-six feet, and the damage to paper-mills and other works, together with the ruin of private houses, was very great.

ALLEGED LAW OF METEORIC SHOWERS.—M. André Poey states in *Comptes Rendus*, that the periodical return of meteors in August and November appears to be confined to high latitudes of the temperate zone, and probably to glacial regions, while extraordinary showers of meteors in swarms embrace the entire surface of the globe; and he asks whether the northern localization of periodic returns can be explained by supposing the descending node of the orbit of the meteoric swarm to be very much inclined towards the ecliptic.

VOLCANIC GROUPS OF ETNA AND VESUVIUS.—M. St. Claire Deville observes that sundry communications made to the French Academy by M. Fouqué show that the last great eruption of Etna was coincident with a diminution of eruptive intensity in the Vesuvian group and in the Eolian Isles, which seems to confirm the idea of their being in connection with each other.

PREVENTING BOILER INCRUSTATIONS.—*Cosmos* states that a fine clay dug at Fohnsdorf, and diffused through the water in boilers, has been found to put a stop to hard incrustations. The clay particles prevent the consolidation of the deposit, and it accordingly assumes a soft, muddy form, which it is easy to remove.

Anœctochilus xanthophyllus.

THE INTELLECTUAL OBSERVER.

JANUARY, 1866.

GOLDEN NETTED-LEAVED ORCHIDS.

BY SHIRLEY HIBBERD.

(*With a Coloured Plate.*)

In the year 1836 the collection of orchids at the Royal Gardens, Kew, was enriched with specimens of a genus which, till then, was practically unknown to cultivators, and the name of which is *Anœctochilus setaceus.* This plant came from Ceylon, and was regarded by botanists and cultivators as the most remarkable example of natural colouring which, up to that date, had been seen in English gardens. Among collectors of rare, curious, and beautiful plants, there soon sprang up a spirited competition for possession of examples of this costly gem. Botanical travellers and the spirited trading firms by whom the majority of plants collected are sent out, were stimulated to use every exertion likely to tend to the importation of such plants, and the result has been a constant accession to our lists of cultivated plants, of species and varieties of the same genus, so that now a good collection of Anæctochili constitutes a most important feature in a plant-stove. The reason of the interest taken in these plants is the beauty of their leaves. They are not uninteresting as flowering plants, and were the leaves less attractive than they are, a few would probably be cultivated for the sake of their pretty and comparatively simple flowers. As the case stands, however, very few cultivators care whether they flower or not; many have never seen them flower; and some forbid them to flower by nipping out the spike as soon as it appears; and on the other hand, the intense admiration which prevails for their wonderful leaves causes such an activity in propagating the plants that some of the species have scarcely yet had an opportunity for the development of their flowers. If any

reader, unlearned in botany and horticulture, desires to know something of the nature of the claim these plants have upon the admiration of the connoisseur, the accompanying plate will explain it better than pages filled with description and eulogy. It may be said, however, that eulogy in this case is impossible. No picture, no description, no perfervid expressions of surprise, delight, or even of admiration, bordering on worship, can convey an adequate idea of the extraordinary beauty of these plants. They are of humble growth, averaging from two to six inches in height, and may be described as perennial herbs. The majority have a distinct, fleshy stem, neat ovate or lanceolate leaves, fleshy leaf-stalks, and their roots proceed direct from the base of the stem, without any intermediate bulb, as in the majority of orchids.

Considered irrespective of their colours, these plants are remarkably neat, and have a character all their own. If the wonderful tracery of their leaves was all washed out, we should still be compelled to admire them for their graceful attitudes, their unassuming elegance, and the beautiful harmony of their proportions. But with these good qualities, they present us with a comment, all unthought of by the poet, who framed the question, "Who can paint like Nature?" In all the families of plants, so various in forms and colours, sometimes so gorgeous that they rival sunsets and repeat rainbows, there are no examples of colouring known which can be fairly said to divide with these the praise of being most wonderful and most perfect.

Usually the leaf appears as if formed of the richest purple, green, or olive-coloured velvet, or glossy satin or silk. Over this groundwork is spread an elaborate reticulation of gold or silver threads, the veining of the leaf being marked out as distinctly as if wrought in real metal of the most cunning workmanship; and, unlike the picture before us—which is the best that can be done by art of man—the gold has the lustre of gold, and the velvet the softness, and iridescence, and "touch me not" delicacy of velvet, and the whole thing is so wonderful that though we may have been familiar with the plants for years, we have never yet become thoroughly convinced of their reality. Those can best believe them to be real who have made fortunes by trading in them. The amateur who keeps them for his enjoyment solely may be permitted to dream on and persist in their unreality, and if there is no wild eastern legend of angels having lost their wings when engaged in missions of mercy in the Indian Archipelago, or of some fragments of the jewellery of heaven having been let fall to give human creatures an idea of the material equivalents of spiritual perfections; if there are no

such legends there ought to be, and the writer of this lives in hope of some day discovering that these plants are as deeply rooted in the fertile soil of Oriental poetry as in the hearts of those amateurs who regard them as the most precious of all their phytological treasures.

There is a consideration always present to the mind of the present writer, and it is this: that the most wonderful of plants are weeds somewhere. Orchids that sell for fifty or a hundred guineas each in this country exist somewhere in countless thousands, and grow and bloom with rampant strength amongst the rubbish of tropical swamps and forests, making paradises of colour and fragrance for themselves alone, and for the few wild creatures that keep them company. So with the species of Anæctochilus, which travellers tell us are hedgerow weeds in Ceylon, wildings of the waste in Borneo and Java, rarities of almost priceless value with us, yet scattered as profusely amongst the damp shady woods, and amongst caverns and swamps in the hotter parts of the East as chickweed, and crane's-bills, and primulas are in all the waste places of our own land. *A. setaceus* is reported to be known as the "king of the woods" by the Cingalese, who of necessity appreciate its beauty, and only value it less than we because it is common of the commonplace, and where it grows they tread on rubies, pearls, topazes, and velvet, and gold and silver lace.

Cultivators of these plants have a constant source of interest and curiosity in the difficulties that have hitherto attended the keeping and increasing their specimens. The gorgeous colouring of these plants suggests a difficulty in cultivating them, and accordingly many failures have occurred where there has been no lack of enthusiasm or of appreciation of their beauty. It has been the fate of nearly all the species of orchids introduced to this country to be overdone with heat and moisture, and killed with too much care. The Anæctochili have shared in these calamities. They have been stewed, starved, roasted, and stifled, and they have disappeared from the scene they were intended to enliven often enough to justify a few remarks here upon the true principles and routine of cultivation. I have seen a great many good and bad collections, and have noticed the effects of various kinds of treatment, and the result is that I believe very few private growers have as yet become fully aware of the capabilities of the plants for the decoration of orchid houses, or of their marvellous individual beauties. The common failing is too much heat, and too close and steaming an atmosphere, conditions which debilitate the plant, diminish the brilliancy of its colouring, render it tall and spindling when it ought to be short and sturdy and robust, and sometimes cause its death at the very mo-

ment when it ought to be in full perfection. What is called "cool treatment" must, however, not be attempted, though Mr. Lowe, in his *Beautiful Leaved Plants*, tells of a specimen of the lovely *A. xanthophyllus*, which was kept in a greenhouse, shaded by a tent of paper, where the temperature frequently fell to 35° during November and December, yet the plant was always in perfect health, and lost none of its leaves. Shade and warmth are indispensable. During the winter the night temperature may descend to 50° with perfect safety, but a good average is 55°, and the average day temperature should be 60° to 70°, the last-named being the rise allowed during sunshine. After March the plants begin to grow vigorously if properly treated, and the temperature should rise to an average of 65° at night, with 60° for the minimum and 70° for the maximum, and during the day they will enjoy a heat of 70° to 90°, the best average being 75°.

During the growing season water must be given plentifully at the roots, but *not a drop must touch the leaves*, a rule to be strictly observed in the cultivation of all delicate plants that have got pilose leaves, such as Begonias, Cyanophyllums, Sphærogynes, etc. In winter, also, they must have water enough to keep the roots always moist, but great care must be taken not to give them too much, or disease will be the consequence. On the other hand, drought is death to them. Sunshine is decidedly injurious, but they need plenty of light when grown under glass, and on that point a special remark must be made presently. They make but few roots, and must always be grown in small pots; the best soil is chopped sphagnum; all mixtures of peat, loam, and leaf-mould, as recommended by persons who have never grown these plants, or who have grown them badly, are objectionable. The sphagnum should first be scalded, then chopped fine, and mixed with an equal bulk of silver sand and broken pots of the size of peas. The pots should be quite clean, and should be half filled with crocks, over the crocks some unchopped sphagnum, and then the mixture heaped up in a convex form above the level of the rim of the pot. In fixing the plant, a little pure sand had best be used to fill in next the collar, both to prevent bruising the stem and also to support it more firmly. One or two small pieces of stick are generally requisite to support the plant until it has made fresh roots. In any case of a plant appearing unhealthy, the best course is to remove the soil carefully from the roots and repot it afresh, and encourage it to make fresh roots. After being newly potted, it is best to place them in close cases, or under bell-glasses, for about a fortnight, after which it is certainly better to expose

them to the general air of the stove, than to keep them constantly under dell-glasses.

Opinions and practices differ on this point. Mr. B. S. Williams, of Victoria Nursery, Holloway, is one of the most successful cultivators of these lovely plants, and he prefers bell-glasses, but is very particular to have them removed occasionally and wiped dry, so that there is not for any length of time a stagnant moisture in contact with the leaves. This practice prevails largely. But I have seen some very good collections in perfect health, where bell-glasses were used only on occasions of repotting and dividing the plants, when they certainly render an important service. I shall not soon forget the beautiful examples in the East India Orchid House, at Pine Apple Nursery, Edgeware Road, where Mr. A. Henderson follows the system I am recommending of exposing them to the common atmosphere of the house, which of course is free from draughts, always moist, and the temperature properly regulated for these and other inmates. The advantages of abolishing glasses are many. In the first place, the plants are seen in all their splendour as components of the general display. When glasses are used, they form no part of the display, and we only see them when making a special investigation of them. Another advantage is that they bear a higher temperature without injury, and are not so soon stewed to death as when shut in close with an excess of moisture about them. A third advantage is saving of expense and trouble, two items of least importance in this case, because growers of Anæctochili are not usually sparing of either. Nevertheless, a saving is a saving, and it deserves mention. When the cultivation is attempted in a warm greenhouse—and an ardent admirer of these plants, having no other convenience, may certainly try a few with a fair prospect of success—bell-glasses or a box with glass top must be used, both to protect them from draughts and from too arid an atmosphere. If opinions are divided on this point, there will be no demur to the proposition that they should not have bottom-heat. If the general temperature of the house is right, then all is right in that respect, and bottom-heat is neither necessary nor desirable.

There is another point of importance, of great importance indeed to the botanico-cultivator. It is this, that it benefits the plants to allow them to flower. The general opinion is that the flowers should be nipped out, in order to throw all the vigour of the plant into the leaves, that the leaves may be fully developed, that they may have their proper lustre and richness of painting. Well, the consequence is that an immense number of plants have been lost, through not being allowed to bloom, and much enjoyment has been lost also for the

flowers are at least pretty, if they are quite outdone in glory by the leaves. We have yet much to learn of the extent to which plants may with impunity be denuded of their flower-buds, or have their seminal germs suppressed; in many cases the vigour of the leaf is visibly increased, in others it is not so, and many plants have no doubt been lost to cultivation by a mistaken interference with nature's order of procedure. In the case before us, it may be stated without hesitation, that it is good for the plants to flower, and the cultivator should hail the flowers with a welcome.

The Anæctochilus belongs to the *Neottieæ* section of Orchidaceæ. The genera of this section are characterized by having powdery pollen, a dorsal anther, almost parallel with the stigma, or with the face of the column. For congeners they have but few important genera. We find in this section the interesting *Prescottia*, our British *Listera* and *Neottia* and *Epipactis*, the beautiful *Spiranthes*, the chaste *Goodyera*, also renowned for the beauty of its leaves, and these are about all that are of much interest to cultivators out of the eighty established genera, of which the section consists. The principal characteristic of the flower of Anæctochilus is the spreading apex of the lip, from which it takes its name. The flowers are usually white, produced in light, graceful, rather sparsely furnished spikes, and they may well be likened in general appearence to the flowers of the pretty "mother of thousands," *Saxifraga sarmentosa*, which is a good substitute for an orchid in a poor man's garden, and is less often seen in a flowering state than it should be.

Considering the activity of plant collectors, and the botanical wealth of the regions whence the Anæctochili at present known have been obtained, it is fair to anticipate that in a few years there will be hundreds of species known to science. At present the species in cultivation number about thirty, and the following are the most notable for their distinctness and beauty :—

A. argenteus grows to a height of four inches; leaves large, light green, with sharp lines of bright silver. Easily grown, and if warm enough never requires a bell-glass.

A. argyreus. A Brazilian species, with long, narrow green leaves, marked with silvery lines, the central space between the lines greyish.

A. Bullenii grows six inches high; leaves large, bronzy green, with three broad lines of coppery red, which occasionally change to bright gold. Difficult to grow, and requires a bell-glass.

A. Dominii. A hybrid between *Goodyera discolor* and *A. xanthophyllus*, obtained by Mr. Dominy, principal cultivator

at Messrs. Veitch's establishment, and the greatest hybridist of modern times. The leaves are dark olive green, with a pale coppery tinge down the centre, the main ribs marked out by fine pallid lines, and connected by means of light reticulations.

A. El Dorado. Useless and unattractive, except in the hands of the most expert cultivators. It is deciduous, the leaves dark green, with light tracery.

A. intermedia grows three inches high; one of the most beautiful and easily grown, it does not need a bell-glass. Colour, dark olive striped with gold. Deliciously silky and the habit very fine.

A. Javanicus grows four inches high; leaves olive green, blotched with light green; suitable only for large collections.

A. Lobbii grows three inches high; leaves large, dark olive, with elegant light markings; a fine species.

A. Lowii. The largest of the genus and one of the grandest, grows seven or eight inches high, with oval acuminated leaves four or five inches long and three broad, the ground colour a solemn purplish bronze with longitudinal veins of bright gold, connected together by transverse reticulations. The most easy to cultivate of any. It is probably the loveliest of all known plants on the face of the earth.

A. maculatus grows five inches high; leaves marked with frosted silver in the centre, and with margin of rich dark green. A fine species, and easy to grow.

A. Nevilleanus grows three inches; leaves dark olive, blotched with orange; difficult to grow.

A. petola grows four inches; leaves light and velvety, with bands of deep gold. A very fine species, and easy to grow.

A. querceticolus grows four inches; colour light green, with white blotches. Grows freely, but not desirable in small collections.

A. Roxburghii grows three inches high; leaves dark, velvety, superbly veined with lustrous silver. There are several kinds in cultivation with this name. The true Roxburghii is superb, and rather difficult to keep in good condition.

A. Ruckerii grows four inches high; leaves broadly ovate, ground bronzy green, with six rows of spots extending the entire length of the leaf. Very distinct and fine; rather difficult to manage.

A. rubro-venia. Sometimes classed with Goodyera, but not justifiably so. Grows four inches high, has beautiful ovate leaves of a blackish green colour, marked with sharp longitudinal lines of reddish crimson extending their whole length.

A. setaceus. A very fine species. Grows four inches high;

leaves velvety, the ground colour a dull mixture of olive and chocolate, with sharp longitudinal veins and connecting reticulations, all of the most refulgent gold. The leaf of this glorious plant probably approaches nearest in resemblance to some exquisite work of human art of any natural production, the leaf appearing to be wrought in the richest velvet, and most delicate and cunning golden filagree work. Under the microscope the veins have a strong red hue, and their beauty is such that any attempt at description would be ridiculous. It grows well, but requires great care, especially to preserve the leaves from excess of moisture. There are several varieties, and all are good.

A. striatus. A pretty slender species, growing five inches high. Leaves ovate-lanceolate, bright cheerful green, with shades of purple and bronze, and a broad, bold rose and white stripe down the centre; grows well, and does not need a glass.

A. Turneri. Recently introduced by Mr. B. S. Williams, and named in honour of J. A. Turner, Esq., of Manchester. It has a stout robust habit, leaves broadly ovate, colour rich bronze, freely marked by golden and coppery reticulations. A superb species, apparently quite easy to manage.

A. Veitchii grows six inches high; leaves large, light green, richly reticulated all over with sharply defined lines. Grows freely, and does not require a bell-glass.

A. xanthophyllus grows five or six inches high; leaves ovate; ground colour deep purplish brown, and of the richest velvety texture; in the centre a broad lenticular band of yellowish green, extending from the base to the point; longitudinal lines of refulgent gold connected by reticulations of the same colour. A splendid and distinct species. Grows freely, and may be easily managed.

ON MUD VOLCANOES AND SALT LAKES IN THE CRIMEA.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

A RECENT visit to the eastern part of the Crimea, and the flanks of the Caucasus, and a previous acquaintance with part of the Carpathian chain, have suggested to me a relation of some importance between mud volcanoes, volcanic eruptions of the ordinary kind, and the form of large tracts of land elevated above the water level. The following remarks, founded on these observations, are partly descriptive and partly practical, as referring to economic products. The phenomena of mud volcanoes have not perhaps attracted that amount of attention that seems due to their great extent, wide range, and general parallelism with lines of elevation on a large scale.

The form and extent of land of the old world may be said to depend on certain grand physical facts outlined in the mountain chains. Excluding those mountain chains, which, from the complete denudation they have undergone, may be regarded as of very ancient date—chains in which the only really igneous rocks are now greenstones, and of which only the hard metamorphic and crystalline rocks remain, it is not difficult to define the line of elevation or general axis along which upheaving forces have acted on the largest scale. In the old world this line or axis is distinctly double, and an important space is contained between the two axes. Thus the northern axis, commencing with the Pyrenees, is continued by the main chain of the Alps and the Carpathian mountains, connects by the Crimean chain with the Caucasus, and by that again with the Hindu Koosh and the mountains of the north of China. The southern line commences with the Atlas mountains, and runs on, though not without interruptions, by the mountains of Ethiopia and Arabia to the vast culminating mountains of the Himalayan range. Approaching the Pacific, the mountain line or axis of elevation becomes north and south, corresponding with and meeting that of the great American continent.

But between these two main lines of mountain, which consists chiefly of stratified rocks, either entirely masked or only partially metamorphosed, there exists a number of districts, having the same general direction, remarkable for volcanoes or for volcanic rocks of comparatively recent date. Among the volcanoes, some few, as Etna and Vesuvius, are active; others, as Mount Ararat and some of the highest of the anti-Taurus chain, are exceeding lofty, and are now not erupting, but have been in activity during the later tertiary period. In many

places there are no volcanoes, but abundant stores of basalt and other igneous rock. But the main point for consideration is the fact that along the whole space between the north and south axis, as marked by the presence of lofty mountain chains, and principally towards the northern of the two chains, volcanic eruptions of comparatively modern date have taken place, while on the other hand there are but few and slight indications of this kind in the great plains to the north or south of the lines of elevation.

While active volcanoes are comparatively rare within the great area here alluded to, there is no want of an inferior kind of activity, proving that at a very moderate depth below the surface there are still many connecting links, though perhaps of a somewhat obscure kind. Earthquakes may be regarded as among these links, but mud volcanoes are the most manifest and direct. Sulphur springs or springs of water charged with sulphur, and sulphuretted hydrogen gas, and petroleum springs, are, at least in certain districts, common phenomena. Salt lakes under certain circumstances afford similar indications.

Most mud volcanoes, whose history is at all complete, may be traced back to an origin essentially volcanic, although at the present time the eruption may consist only of mud, at a temperature considerably below the mean temperature at the surface. And this history is not old. Thus in Java, in Peru, and on the shores of the Caspian Sea and the Sea of Azof, either within the present century, or at least within less than a century from the present time, there have been eruptions of boiling mud, accompanied by flame blazing up to a great height and visible at a great distance. It is said that large fragments of rock have been ejected from such craters, and it is certain that many gases and great volumes of gas issue forth. At present there are only cones erupting cold mud, gases, and water.

The distribution of these phenomena is by no means irregular. They may be traced along an unbroken line of fifteen hundred miles from east to west, and they re-appear at intervals to the west, always on or near the direction of the same line. They are also near enough to volcanic phenomena of the ordinary kind to justify the belief that they are very intimately related to them. It has appeared from recent investigations that they are also near and have much relation with important springs of naphtha or petroleum, a product so important at the present day as to justify any amount of investigation that may seem likely to add to the general stock of knowledge and facilitate discovery in this matter.

The mud volcanoes that break out in the peninsula of Kertch, and are continued eastward through the peninsula of Taman, belong to an exceedingly remarkable line of volcanic

action, extending from the Putrid Sea in the Crimea to the south flanks of the Caucasus, and thence to the Caspian Sea, where in the long-celebrated naphtha springs of Baku, and the more recently known, but not less important, springs and mud volcanoes of several islands on the eastern side of the Caspian, there appear to be large and inexhaustible supplies of mineral oil, whose issue is accompanied by emanations of gas. The naphtha springs of Baku are repeated with accompanying mud volcanoes near Teflis, and the petroleum springs of the Crimea are repeated in like manner on the flanks of the Carpathians.

One of the most recent published statements of the commencement of a mud volcano, is referred to by Humboldt in the first volume of the *Cosmos*. The case is remarkable for the extraordinary height of the flames, and it occurred near Baku, in a district in which it is not unusual for columns of burning gas to be continually flaming from holes in the earth, connected with large deposits of petroleum. There is thus a relation suggested, which a further consideration of the position of mud volcanoes will, I think, show to be real and not fanciful.

I now proceed to the description of the instances recently visited by myself, or made out by careful inquiry on the spot. These localities alluded to are near the town of Kertch, in the Crimea, being within a hundred miles to the east, and the same distance to the west of that spot. The whole district occupies an interval between the Caucasus range and the mountain range of the south of the Crimea. The former is chiefly cretaceous, and culminates in the lofty mountain of Elburz, rising to the height of 18,500 feet. The latter is jurassic, and its highest point is 5185 feet. Except the Delta of the Danube, there are only the low hills of the Dobrudcha and the plains of Wallachia, between the extremity of the Crimean range and the eastern Carpathians, which rise in cretaceous peaks to nearly ten thousand feet. Mount Elburz itself is volcanic, and there is a vast development of basaltic rock a little to the south from Teflis to Mount Ararat, which as I have showed is a volcanic cone.

Although, however, the mud volcanoes are near volcanic rock, and connected in all probability with volcanic agency, they all break out in clayey and marly strata of the tertiary age. A broad tract of older, middle, and newer tertiaries, consisting of alternate bands of marl and clay, with overlying limestones often unconformable, extends uninterruptedly on the northern side of the Caucasus and the Crimean chain, occupying the whole of the vast plains so characteristic of that part of Europe and Asia. It is through faults in the clays and other lower rocks—all, however, tertiary—that the water rises charged

with various gases, and issues forth as thin fluid mud. Through the same or similar faults, rises to the surface waters loaded with sulphuretted hydrogen, such as those which give its name to the Putrid Sea; and through similar faults, generally parallel, there rises to the surface that mineral oil or petroleum which is used on a large scale in Baku and its neighbourhood, but which is perfectly available in a number of localities whence no one as yet has taken the trouble to extract it in any systematic way. Certainly the chemist is needed in these interesting spots, to enable the owners of the soil to avail themselves of the large stores of mineral wealth nature has provided; but the geologist has already made known the existence of the treasure.

The first clear and well-marked case of a mud volcano in action that came under my observation in these districts, was a few miles from Kertch, about a mile to the north of the old fortress and Turkish town of Enikale or Yenikale, a place well-known during the Crimean war, but little heard of before or since. Small wells or pits have here been dug in a white chalky rock, dipping almost vertically towards the north-east, and a spring of sulphurous water with bubbles of gas slowly but incessantly rises to the surface—these are the first things seen. These springs and wells are in a line running up from a salt marsh by the sea-side, in a direction N. 70° W. A continual gurgling noise was heard at the surface at the time of my visit, and the temperature of the water was 71° F., that of the air being some degrees lower. About one mile to the north-east of this line of springs is a line of mud volcanoes almost exactly parallel to it. Here again are both sulphur and naphtha springs, but not abundant; but close by there is a perfectly conical hill, not now erupting, and a number of lower hills, much smaller, but still of considerable size, from which mud was slowly issuing at the time of my visit.

There is something exceedingly curious in these little cones. In one of the most recent and regular, though by no means the largest, I measured a stream of thin, black, and perfectly fine and soft mud, nowhere more than a few inches in width, running slowly for a distance of about sixty yards, and falling nearly twenty feet in this distance, or about one in nine. The mud issued steadily, and at intervals of about four seconds a large bubble of gas sedately made its way to the surface and burst. This gas had neither taste nor smell. It was probably nitrogen, a gas which Humboldt had previously detected in the Crimean volcanoes. The temperature of the mud was 56°, much below that of the air at the time. This temperature agrees with that recorded as characteristic of most of the mud volcanoes of the district. A spring of water rising close by showed a temperature of 66°, and this water was sulphurous,

though not to any great extent. The mud stream very gradually became slower, as it was more distant from the vent, and ultimately tended to raise the cone, not escaping into the neighbouring valley.

Close to this vent was a crater-shaped pool of water, measuring about twenty-five paces in circumference, and through the water filling this pool large bubbles of gas were rising at the rate of about thirty-six per minute. A large conical hill is immediately adjacent. I noticed that while the mud volcanoes in action were made up entirely of the peculiar fine black marly mud emitted from the little craters, the adjacent conical hill consisted also of numerous fragments of ironstone, and some angular fragments of marly limestone, such as I observed to exist in, and be highly characteristic of, the shales through which the springs rise. They were only present in small fragments, but they were everywhere, and very abundant.

A short distance beyond, but always in the same general line, are other cones of precisely the same kind. Some are extinct and covered with vegetation, others are still bare, but not now running, and a few are pouring forth small streams of cold bubbling mud or thin paste. Of these streams a few reach the small valley below, but most of them do not reach more than a few yards, or even a foot or two. Some are just commencing, others just concluding. The whole proceeding is languid enough, but is a curious illustration of the changes going on in the earth's interior, and it has singularly modified, and even created, the chief physical features of the district.

Passing along to the west, about six miles, over a limestone hill, and through a clay valley, we come to Boulganak, where there is a large and remarkable *coulee* of mud from a cone of considerable size and height, with several smaller and newer cones close around it. Over a space, at least fifty yards in diameter, there is a bare, rugged, cracked surface of mud. Numerous similar heaps, to the number of upwards of twenty, may be counted within a narrow belt of land, about sixty yards in length. The temperature of the mud in all these cases was about 58°, or two degrees higher than at Enikale. Here, as at Enikale, I found ironstone in small fragments, and some fragments of limestone on the sides of the older cones, but none could be found amongst the mud recently erupted. The general direction of the belt is from E.N.E. to W.S.W., and petroleum springs exist in the neighbourhood.

It is certain that near this place, though not at the exact point where the mud is erupted, there are springs yielding naphtha. The naphtha, however, is independent of the mud, and not abundant. There are also sulphur springs. Some old

Tatar wells, sunk a few feet into the earth, have yielded naphtha in former times, and it is evidently the result of the experience of the Cossacks, who have been accustomed to dig for the rock oil to light their houses and cook their food, that the wells must be sunk in a line of no great breadth, generally running near that of the mud volcanoes, which is approximately W.S.W. and E.N.E., and more or less nearly parallel to it.

Still in the same direction, but ten miles beyond Boulganak, is one of a number of remarkable salt lakes, characteristic of this part of the Crimea. Its shape is roundish oval. It is separated from the Sea of Azof only by a narrow belt of sand-hills. It is only about three miles across in the widest part, and its level is some feet below that of the adjacent sea. The waters of this little lake are intensely salt, and totally different from those either of the Black Sea or the Sea of Azof. The following tabular statement will illustrate the nature of the difference. It is taken from a Russian pamphlet recently published in Odessa, by M. Haskagen of that city. The specific gravity of the Tchokrak water is stated to be 1·13807. That of Black Sea water is considerably lower than ordinary sea-water, which contains 3·4304 parts in a hundred of salts of various kinds, in solution of which two thirds are common salt, and one seventh is chloride of magnesium.

Composition of the Waters of the Black Sea and Lake Tchokrak, and of the Mud of Lake Tchokrak.

[One hundred parts of the water of the Black Sea left after evaporation 1·5258 parts, and the same quantity of Lake Tchokrak water left 14·079 parts. One hundred parts of wet mud of Lake Tchokrak, taken in its ordinary state from the shores of the lake, contained water sixty-one parts, residuum thirty-nine parts. The sixty-one fluid parts of the mud contained 12·964 parts of soluble salts and substances.]

	BLACK SEA.	TCHOKRAK WATER.	TCHOKRAK MUD.
Chloride of sodium	1·3021	6·650	5·860
Chloride of calcium	0·0179	0·120	0·095
Chloride of magnesium	0·0292	4·546	3·073
Iodide of sodium	0·0004	0·050	0·041
Bromide of magnesium	0·0008	0·008	...
Sulphate of lime	0·0104	0·269	0·062
Sulphate of magnesia	0·1481	2·358	2·080
Sulphate of ammonia	...	...	1·659
Organic matter and sulphur	0·0169	0·078	0·094
	1·5258	14·079	12·964

It is impossible to examine this table without being struck by the enormous load of common salt, chloride of magnesium, and sulphate of magnesia contained in the lake waters. So great is this quantity, that for many years past it has been found advantageous to dam back the waters of this lake, and evaporate them during summer. Good common salt and abundance of Epsom salts are thus obtained; but the latter is not in sufficient demand to be of any value, and it is left in white snow-like heaps on the shore. It is thought that the annual supply of common salt is diminishing.

But although the water is remarkable enough, the mud at the bottom of the lake is still more singular. The composition of this mud taken in its ordinary state at the upper end of the lake, or that farthest from the Sea of Azof (with which, however, there is no communication whatever) is given in the table. The depth of the mud (always of the same nature) is greater than has been found possible to measure by any means attainable on the spot. It is certainly more than forty feet. The following is the composition of the insoluble part:—

Insoluble part of the Tchokrak black Mud.

Sand	35·061
Carbonate of lime	31·090
Sulphur*	9·116
Clay	19·630
Oxide of iron	9·003
Sulphate of iron	3·050
Organic matter	1·050
	100·000

The mud of this lake has very remarkable curative powers, and is said to perform cures almost miraculous in cases of scorbutic sores and chronic rheumatism. It is of the most inky blackness, and has a strong smell of sulphuretted hydrogen. The method of bathing in it is so curious as to be worth mentioning here. The patient is stripped, and lies down on his back in a kind of coarsely-made box, or coffin, partly buried in and quite filled with the mud. The mud is in a pasty state, so that the body hardly sinks in it more than into a feather-bed. When the bather has laid down in this way, an attendant heaps more mud, so as to cover completely every part but the

* The exact meaning of this I am unable to give. As I was informed it included various sulphurous substances, but chiefly sulphur. My informant, however, an intelligent Russian gentleman, was no chemist, and not familiar with either Russian or French technical terms.

face. This is all done in the open air, and a small kind of wooden parasol is so placed, as to prevent the eyes and face from being injured by the fierce burning heat of the sun. The patient thus completely buried in the black stinking mud, is left exposed to the sun for a considerable time, and soon breaks out into a profuse perspiration. It is said, that on being removed and placed in a bath of fresh water, the body is found to be much less blackened and dirtied than might be imagined. It is certain that a finger placed in the mud cannot be cleaned without much trouble. The perspiration is believed to be the cause of the difference, and there are left in the mud, after the bather has removed, small pools in the depressed parts of the moulds that seem to afford proof of this part of the efficacy of the treatment. At the time of my visit, the establishment, which consisted of a few constructions of planks, contained only two patients, but this was at the commencement of the season. I saw the *forms* or moulds of these victims after they had bathed, and they were interesting and curious enough, the whole outline and shape of the body being perfectly recognizable.

I have described the nature of the water and mud of this curious lake, because it is really of great interest in reference to the natural history of the district. The lake in question is, I believe, one of the results of the peculiar action that under some circumstances results in the formation of the crater of a mud volcano. This lake is, in fact, the connecting link between the mud volcanoes, eruptions of naphtha, saline waters, and sulphurous gases frequent near the extremity of the Crimea, and recurring in the fetid exhalations of the Putrid Sea, which are due to precisely similar causes, and which again may be traced across the southern steppes to the flanks of the Carpathians, where petroleum springs and mineral oil exist in considerable quantities.

To the south-west of the town of Kertch, at a distance of about five miles, is one large inactive cone, within a large crater, and immediately adjacent are a number of hillocks, consisting of mud erupted from mud volcanoes which are still active. A line of such hillocks extends for some miles towards the east, and a line of petroleum wells is traceable in the same direction. In one of these traces of naphtha were reached at a depth of only 17 feet from the surface. The well was sunk through clays and ironstone bands, inclined at an angle of more than 45° to N., and at a depth of about 60 feet from the surface, a large quantity of oil, apparently a steady supply, was reached at a peculiar sandstone loaded with bitumen. Other wells and borings beyond the outcrop of these sandstones, and also beyond the mud-volcano to the south, failed in getting any

supply, although the oil was several feet deep in the bottom of the first well.

In the case at present before us (Girjarva) the interest is greater than at Boulganak, inasmuch as the extinct mud-volcano, the active little craters around the oil-well, and an entire village, are all contained within the hollow of one large crater, of which one side (that to the south) is capped with limestone, from underneath whose beds springs of tolerably pure though rather saline water issue. The level of the bottom of this larger crater, which is open on one side (towards the north), and which is remarkably regular, is about 100 feet above the sea, as measured by an aneroid barometer under circumstances not very favourable. Sulphur springs come out to the south in a small valley removed from the crater by limestone hills. That the Lake Tchokrak already described is a similar crater, at a lower level, and in which the supply of water has been kept up, but which is also due essentially to volcanic agency, I have no doubt. It is only in this way, I believe, that the peculiar nature of the waters and mud can be accounted for.

Another curious and much larger lake of the same general nature, and due to similar causes, is about twelve miles south of Girjarva, and is called Tchongolek or Tobetchich. Like Tchokrak it is rounded in form, although a kind of inlet creek running to the west, in a direction opposite to the sea, gives it a peculiar form. It resembles very closely the shape of a pear. It is separated from the Black Sea by a low narrow causeway, a hundred yards or so across. The level of the small lake of Tchokrak is much lower than that of the Sea of Azof. Tchongolek is also lower than the Black Sea, but the difference is not great. Estimated by a good aneroid under favourable circumstances, it was not more than five feet. This is caused by evaporation, as there is no communication with the sea.

Like Tchokrak the waters of Tchongolek are very salt, and the mud intensely black and sulphurous. Both water and mud are somewhat less rich in products. On one part of the shore of the lake is every appearance of a crater, but the rock is here a marly limestone inclined at a very high angle (nearly 80°), and a little beyond is a string of old Tatar wells, and a number of recent sinkings and borings for petroleum. Some of the sinkings have been successful. There are salt works on this lake on a somewhat large scale, but here as at Tchokrak the sun is the only evaporative agent. Another salt lake is passed on the coast between Girjarva and Tchongolek, and there are several between the latter and Kaffa.

Crossing the Straits of Kertch we reach several low straggling fingers of land that project from the most westerly spurs of the Caucasus towards the Crimea. Between them is the

Liman or delta of the river Kuban, the principal stream draining the northern flanks of the great Caucasian chain. On all the fingers thus jutting out there are lines of elevated land, consisting almost without exception of mud volcanoes, either now active, or having very recently erupted. One of these, about 250 feet in height, is known to have erupted with much flame to a height of fifty yards above the ground. This lasted for half an hour, and was accompanied with thick black smoke; noises like thunder were heard during the eruption. Very large quantities of mud were then thrown out, but though the expression "boiling" is used with reference to the eruption, the temperature is not mentioned, and the bubbling of gas through cold mud may have been meant. The mud thus thrown out is said to have spread over the plain. The rapid eruption of mud was soon over, but subterranean noises were heard for some months. The phenomenon occurred on 27th February, 1794, and is described by the well-known naturalist Pallas. Twenty years afterwards the appearance is described by Engelhardt, who speaks of two craters, each about fifty feet in diameter, from which issued gases neither combustible nor inflammable. These gases bubbled through saltish water at a temperature of nearly 100° F. At the present time, after a further interval of rather more than half a century, this vent has almost closed up, and no knowledge or recollection of it exists among the few inhabitants of Taman, the small town on the peninsula. I had some difficulty in getting to it, although it remains a volcanic cone of great beauty, at least 250 feet above the flat plain of the delta, and possessing a crater of very distinct form. It is perfectly visible from Kertch and the Straits, and is a highly picturesque object. It is, however, not very accessible, and although close to the water, a long detour of nearly sixty miles is necessary to reach it. It has lost its characteristic names, and instead of being called "*Prekla,*" or hell, by the Russians, as described by Pallas, it is now only known as "*Gorèla,*" or the hill. Another name, "*Kakuoba,*" given in Colonel Jervis's and other good maps of the Crimea, was not recognized by any one.

Gorèla at present offers at a little distance the appearance of a perfect cone, about two miles in diameter at the base and 250 feet high. There is one opening at the south side looking towards Taman, resembling a large broken crater, and a small crater at the top with a pool of water. At the time of my visit there were marks of two or three recent *coulées* of mud, one of large size, probably within a twelvemonth, as there was no growth upon them. There were others older and now covered with vegetation. The sides of the cone consist chiefly of mud, but are covered with innumerable fragments of hard red

clayey iron oxide. There is no other cone, and no mud volcano of importance within several miles, and indeed no other on the tongue of land terminated by Goréla.

About sixteen miles east of Goréla, and on another long tongue of land to the south, on which is the small town of Taman, there is a group of mud volcanoes now very active and of considerable magnitude. The furthest of these to the east are not far from the post station and village of Aktinisorka, and, as is usually the case, there are several together, the number of actual points of eruption being few, but the evidences of recent activity plentiful enough. There are four hills extremely well-marked, ranging W.S.W., E.N.E.; each has certainly thrown out a very large quantity of mud within the last two years. The cones of mud recently erupted vary from five to twenty feet in height. From the cones actually erupting the *coulées* of mud are large, and the temperature of the mud was 56°. Numerous bubbles of gas are erupted with the mud. Here, as everywhere, I noticed fragments of red clayey ironstone and marly limestone (always angular), lying on the sides of the cones, and evidently due to the outpouring of the mud; but the mud itself as erupted was perfectly smooth, soft, and free from the smallest appreciable grit.

This group of mud volcanoes is at present very interesting. It is called Luvarka. Goréla is well seen from it, as it is the only cone at the extremity of the northern arm of the peninsula; but a chain of hills extends, occupying the middle of the strip of land forming the southern arm, and connecting with Luvarka, all of them having been formed or modified by mud eruptions: Many of these are very large, and have craters several hundred yards in diameter. Some have small detached cones, and the general elevation of the range is nearly three hundred feet. The diameter of several patches of mud recently thrown out varies from a very small space to an area of at least half an acre. In the larger spaces of cracked mud there is sometimes no cone and no appearance of the point of eruption, and nothing to prove the origin but the peculiar nature of the mud itself, which is always the same, and long remains without any growth upon it. The number of points of eruption along this line of hill, nearly ten miles in length, is far too great to be counted.

Throughout the Crimea and Taman it is commonly stated, both by the Russians and the Cossacks, that the eruptions of mud from these vents are more numerous and more abundant in hot dry weather than in winter or during rain. It is also said that the bubbles of gas are more frequent at such times, so that occasionally the mud seems to boil. I found this to be the general opinion also at Kertch; but I was also told there

that when the wind blew from the north the discharge of mud was greatest, and that when there was west wind more petroleum was obtained from the wells.

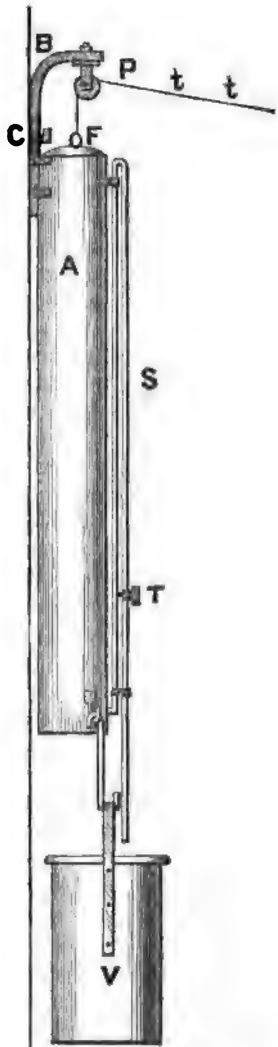
Besides the mud volcanoes and salt lakes already described, a number of other salt lakes exist at various places round the eastern part of the Crimea, both on the Sea of Azof and the Black Sea. They are, indeed, repeated at intervals for a distance of many hundred miles, and in most cases the mud partakes of the peculiar qualities and properties described as characteristic of Lake Tchokrak. The lakes as well as the mud volcanoes occur in all cases in which I was able to examine them in the highly-inclined strata underneath, and unconformable to the limestone capping the hills. The exact age of these it is not necessary here to determine, but there is clear proof that all belong to the Tertiary period, and that the elevations and movements have been continued and repeated to the most recent times. The whole bed of the Black Sea and the Sea of Azof along the broad line containing the mud volcanoes and mineral springs, whether of water or oil, is still in a state of upheaval, as proved by numerous examples of raised beaches.

The general conclusion to be drawn from the facts here recorded is, I think, confirmatory of the opinion that mud volcanoes are due to causes not different in their nature from ordinary volcanoes, though far less powerful in degree. This is fully borne out by the condition of the *salses* of Central Italy. In all of them volcanic forces of other kinds, and of greater intensity, are, or have recently, been active in the immediate neighbourhood. In some, as in the Crimea, there is still a certain amount of force tending to upheave large tracts. But it may still remain a question whether volcanic eruptions, exhibited only by the thrusting out of slow torrents of cold mud, are due to local causes, or are deep-seated and central. I think the facts (1) that the volcanic axis is identical with the great elevation axis; (2) that the axis of the smallest and most recent action of mud volcanoes is, in like manner, parallel to the most magnificent and important movements that have affected the surface of the globe; (3) that chemical changes and results, mineral waters, naphtha, and eruptions of various gases, are all connected very directly with similar lines of action; and (4) that lines of fault, mineral veins, and certain systematic changes that take place in the interior of the earth—are all sufficiently indicative of a general causation, and afford satisfactory evidence that continuous slow steady action in certain definite lines is the law of nature, though occasional outbursts and disturbances, comparatively very small, are also consistent with this grand and majestic progress.

A CLEPSYDRA FOR DRIVING TELESCOPES.

BY FREDERICK BIRD.

THE instrument of which a sketch is here given was devised by me for the purpose of imparting a slow motion to a silvered glass reflector, twelve inches aperture, mounted equatoreally. The tube is suspended on axes in a rectangular wooden frame, terminating in pivots, one of which rests in a socket embedded in stone, and the other drops into a cast-iron Y bearing. The telescope is well balanced in all positions, and moves with great freedom.



The motive power for driving, or rather drawing the telescope, resides in a column of water, containing about one and a half gallons, and placed in a cylindrical vessel, A, of zinc, three feet long, and four inches diameter. On the outside of this vessel, near the base, is inserted a small gas-tube, three-eighths of an inch bore, communicating with the interior. The tube is carried up level with the top, bent sharply round, and brought down again below the base, about six inches, to form a syphon, S.

Eighteen inches from the end is inserted a stop-cock, T, to regulate the flow of water, and a vessel is placed below to receive it. At the upper end of the long vessel, A, and attached to it, is a curved iron bracket, perforated at the back, by which the whole apparatus may be hung upon a nail or hook, C, in any convenient position, if possible, within reach of the observer at the tele-

scope. The curved bracket has also inserted a pulley, P, the frame of which turns freely on its axis.

Inside the vessel A is a float, F, also made in zinc, six inches long, and three and a half inches diameter, air-tight. In the bottom of it is a disc of lead, weighing two pounds, which suffices to depress the float to the level of the water without sinking it. A fine string, *t t*, is attached to a wire loop in the float, and is carried over the pulley, and thence to the telescope.

As the force to be exerted by the float F, in moving the telescope, is not greater than that represented by its weight, some mechanical advantage may be gained by attaching the string to the end of the telescope tube, near the eye-piece, rather than to its frame, or to the polar axis. My own telescope, etc., although it weighs 250 pounds, is in this manner, when clamped in declination, drawn with the utmost facility by the float weighing only two pounds.

Since the accompanying sketch was made two conveniences have been applied which are not here shown. One of these is a "tell tale," which is drawn up outside the vessel A, by a string connecting it with the descending float; this serves to show how much water remains in the vessel. The other is a ready way of regulating the tap in the syphon-tube, when the apparatus is placed out of arm's reach, as it often may be.

It was most convenient in my own case to hang the apparatus against one side of the moveable roof of the observatory, at right angles to the opening. In this position the tap was five feet distant, immediately behind me, when at the eye-piece. To remedy this inconvenience I attached a small lever to the tap, and carried a string from it through a pulley over head in the roof, and brought it down over another pulley to the right hand of my station. By attaching an *equal weight* to either end of the string the tap could be kept open at any degree that might be required, and regulated with great precision without my leaving the eye-piece.

To put the apparatus in action let the vessel A be first placed exactly vertical, so that the float in descending may not rub against the sides; fill the vessel with water until the float rises, and is just visible at the top; suck the air out of the syphon-tube, and when the water follows turn the tap to arrest its flow. The string is then tied to the float F, brought over the pulley P, and slightly secured to the telescope. Let a star be placed in the field, and the string somewhat tightened. In doing this, the probability is, that the instrument, being pulled slightly, the star will escape out of the field, apparently eastward, if it be a reflector. The instrument may then be allowed to rest until the star re-

turns, and as soon as it gets fairly into the field, the tap of the syphon must be turned, causing the water to flow. It may be a few seconds before the string tightens to lift the float, the weight of which has to overcome the resistance of the telescope, etc.; but when that has once taken place, and the telescope begins to follow, the regulation of the water-flow in obtaining the sidereal rate is easy. If the star has got across the field by the time the float is in full action, it is evident the pace of the telescope must be increased, in order that the star may be overtaken; and this may be instantly effected by opening the tap wider, and increasing the flow of water. When the star is overtaken, and it commences moving across the field apparently eastwards, as before, the flow must be gradually diminished, until the star is "brought up." With a very little practice, the sidereal rate may be so closely approximated to, that the star can be made to remain motionless at the centre of the field, and will, of course, continue there until the tube is exhausted of water. In a tube four inches diameter the sidereal rate is represented by a drop of one inch in four minutes and a half; and, therefore, with a tube thirty-six inches long, deducting six inches for the float, an object may be kept in the field of view 135 minutes, a period of time more than sufficient for any single observation. I need scarcely point out that the tube may be put in action again immediately by pouring all the water back into it.

I by no means intend to convey the impression that this apparatus is equal in point of convenience to a fine clock motion, but a most excellent substitute for clock motion it certainly is, and I can therefore confidently recommend it to amateurs who, having equatoreal arrangements, are destitute of a driving force. The cost of the apparatus is small, and it can be made by any tinsmith. If the foregoing description should not appear very intelligible, it will afford me pleasure to answer any questions, or even to get the apparatus made complete for any one who may wish to try it.

General Cemetery, Birmingham, Nov. 22, 1865.

ON THE WELWITSCHIA MIRABILIS, Hook, Fil.

BY JOHN R. JACKSON,

Curator, Museum, Royal Gardens, Kew.

(*With a Tinted Plate.*)

In a recent number of the Intellectual Observer we gave our readers an account of the Araucarias, one of the most interesting genera of the Coniferæ. We now propose to speak of another most peculiar and interesting genus belonging to an order closely allied to that family—viz., the Gnetaceæ, or jointed firs. Seldom, if ever, has the discovery of a new plant created such an amount of interest in the scientific world as the subject of this paper. As a sensational plant, if we may so use the word, nothing has equalled it since the discovery of the gigantic parasite the *Rafflesia Arnoldii*, which so startled the savans about the year 1819. In 1860, Dr. Frederic Welwitsch, an Austrian botanist of some note, who had been exploring some of the regions of South-west Tropical Africa for some time previously, on behalf of the Portuguese Government, came upon an elevated sandy plateau about five hundred miles to the south of Cape Negro, in lat. 15° 40′ S. His attention was immediately attracted to a number of curious formations rising from a foot to eighteen inches above the surface of the ground, varying from two to fourteen feet in circumference, and having a flat, somewhat depressed top of a brown dingy colour, and appearing more like large stools or small tables than any living plant. The amazement caused by first beholding such a scene can very well be imagined; what, then, must it have been to the practised eyes of an accomplished botanist, who, upon nearing the scene, must have been pretty sure that he had alighted upon something to startle his European brethren.

Of course, Dr. Welwitsch's first proceeding was to secure a plant, and the materials for working out its scientific classification. He subsequently addressed a letter to the late Sir. W. J. Hooker, acquainting him of his great discovery. This letter, received towards the end of 1860, containing the first notice of this extraordinary plant, was immediately communicated to the Linnæan Society of London, and naturally excited an intense interest. In subsequent correspondence with Dr. Hooker on the subject, Dr. Welwitsch very liberally proposed to send his specimens to Kew for examination and publication. But twelve or eighteen months elapsed before they arrived, during which time Mr. Baines, the artist, formerly

[illegible] Miscellany.

[illegible] SCHIA MIRABILIS [illegible]

[illegible]

[illegible] Octob[illegible] [illegible] one of [illegible] We now propose to [illegible] [illegible] Dr. Frederic Welw[illegible] who had been engaged [illegible] Tropical Africa [illegible] Portuguese Gov[illegible] lat. 15° 40′ S. His atte[illegible] [illegible] above the surface of [illegible] fourteen feet [illegible] like large stools [illegible] [illegible] to startle [illegible]

[illegible] first proceeding was to [illegible] [illegible] a letter to the [illegible] of his great disc[illegible] [illegible] correspon[illegible] Dr. Hooker [illegible] Dr. Welwitsch [illegible] proposed to send his [illegible] but two [illegible] months [illegible] they arrived, during which time Mr. Baines, the [illegible]

1. **Plant of Welwitschia mirabilis,** Hook fil.
2. **Ditto, with leaves taken off,** shewing the stock.
3. Cones of Welwitschia mirabilis, Hook fil.

attached to the Livingstone expedition, and who had since been exploring Damaraland, transmitted to Kew a case of specimens and drawings illustrating the vegetation of the country, and also some cones, which, together with the assistance of the sketches, Dr. Hooker immediately identified as those of the extraordinary plant in question. Mr. Baines would appear to have travelled after Dr. Welwitsch across the same tract of country, and there likewise to have found the plant; and, though being quite unacquainted with botanical science, but struck by the peculiar appearance, to have sketched it, and obtained some of the cones. These, however, were in such a bad state from being packed when moist, that they did not furnish sufficient evidence to found an accurate botanical description upon, and Mr. Baines's sketch was that of an artist rather than a botanist—or, as Dr. Hooker says, more artistic than scientific. Dr. Welwitsch's materials, as well as various other specimens from friends of Dr. Hooker's in that part of Africa, in answer to his letters, soon after arrived at Kew, and so fell into the best hands for a careful examination and classification. Dr. Hooker being requested by Dr. Welwitsch to undertake this task, which he did, naming the plant "Welwitschia mirabilis," in honour of its discoverer. The result of Dr. Hooker's labours was the subject of one of the most interesting papers ever read before the Linnæan Society; and in its published form, together with fourteen carefully executed plates—the expense of which was defrayed out of the annual Parliamentary grant to the Royal Society for scientific purposes—occupied one entire number of the Linnæan Society's *Transactions*.

The nature of the soil where these plants are found is sandy, hard, and parched, as little or no rain ever falls upon that part of the plain, and scarcely any other vegetation exists. Dr. Hooker, however, says, upon the authority of Mr. Galton, "that though rain never falls, the night dews are so heavy, that a small party of men, residing on the coast, is supplied thereby with water throughout the year."

As we have before said, the Welwitschia rises not more than a foot or so from the surface of the ground, and may, therefore, be called a dwarf tree. The roots which branch just below the stock penetrate several feet into the ground, and so firmly fix themselves, that it was found a very difficult matter to dig up a plant with the entire root. The point of junction between the root and the stock is, in many of the specimens, very marked. The stock in some becoming suddenly larger, or swollen at the point where the root ends, but in others it tapers off towards the root. This appears to be the case more particularly in the younger plants, and would

account for the difference in the descriptions given by Dr. Welwitsch and Mr. Monteiro, the former saying that the stem is but partially buried in the ground, while the latter describes it as being buried up to the point of attachment of the leaves. Specimens presented by both these gentlemen are in the Museum at Kew, and their appearance fully bears out both these descriptions.

The most peculiar part of this extraordinary plant is its crown, into the edges of which at the point of junction with the stock the leaves are inserted. In outline it is of an irregular oval or oblong form. The surface of this crown, and indeed the whole external part of the plant, is of a dirty brown colour, hard, rugged, and cracked, and has been aptly likened by Dr. Hooker to the crust of an overbaked loaf. This part, which is exposed more than any other to the direct rays of a tropical sun, is of course much the hardest, driest, and darkest. It is seldom or never perfectly flat, but is usually sunken towards the centre, or concave. When young, it is at first somewhat swollen here, but as the plant increases in age, it gradually sinks or contracts. From the edges or point of insertion of the leaves towards the centre, the surface is covered with little circular pits, arranged more or less in concentric ridges. These pits are the marks or scars of fallen flower-stalks. Dr. Hooker looks upon these concentric ridges as very possibly representing the annual growth of the plant. This theory, most probably, is correct, for we find that as the plant increases in age it increases much more rapidly in diameter than in height. Indeed, Dr. Welwitsch tells us that he never saw one more than twelve or eighteen inches above the ground, while they sometimes attain twelve to fourteen feet in circumference, and, it has been said, even six feet in diameter.

Another most peculiar feature is the manner in which the leaves are attached to the plant. The division of the crown from the stock is marked by a long transverse slit extending the entire length of each lobe, and it is from these slits the leaves spring.

Dr. Hooker has so clearly described this singular arrangement, that we cannot do better than give his own words. He says, "It is (the slit) nearly an inch deep in the largest specimen which I cut open; it clasps the leaf base throughout its extent when the plant is fresh; but as the latter dies its walls separate, leaving half an inch space between the upper and lower surfaces at the widest part; whether fresh or dry, its orifice is so contracted that there is very little external trace of its existence, and its lips clasp the leaf so tightly that the latter, even when detached at the base, cannot be withdrawn entire. The object of this arrangement is, no doubt, to

protect the young growing part of the leaf from the dry atmosphere."

We must now refer to the leaves themselves, which, like all other parts of the plant, whether taken in detail or on the whole, are very extraordinary. Each plant has two leaves only, corresponding in width to the lobes of the crown, and running out right and left to the enormous length of six feet, and one-twentieth of an inch in thickness. Their normal state is entire, though they are seldom, if ever, seen in that state, as they soon become split to the base into strips or thongs. They lie flat upon the ground, are of a leathery nature, and of a bright green colour, with almost imperceptible parallel veins. The stomata, or breathing cells, are placed in parallel lines, both on the upper and under sides of the leaves, which are described as being persistent during the whole life of the plant, said to be a hundred years. If this be so, which there is no reason to doubt, it is another instance of dissimilarity to most of the other members of the vegetable kingdom; for we know that the first, or cotyledonary, leaves in most plants drop off as soon as the second leaves are produced. Though none of the specimens brought to this country, or any of those seen by Dr. Welwitsch or Mr. Monteiro, had more than two leaves, Dr. Hooker says, "There is no reason why more than this number should not be developed, for the embryo may occasionally be tri or polycotyledonous, as is the case with so many other gymnosperms, including its near ally Ephedra."

We come next to speak of the fruit or cones, which, perhaps, is the only part of the plant having any general resemblance to the Coniferæ. The inflorescence is borne upon dichotomously branched cymes, which spring from the small pits or scars before spoken of upon the crown of the plant, close to the point of insertion of the leaves, and even occasionally below them. The cones, when fully grown, are about two inches long, distinctly four-sided, the sides slightly convex, and of a bright red colour. The seeds, which are contained one in each scale, are surrounded by a broad, light-coloured, transparent wing.

The Welwitschia is diœcious—that is, having its male and female flowers on separate plants. Dr. Hooker says, "I find no female cones on the same plants with the male, nor any female flowers in the hermaphrodite cones; but there are in the cymes of both sexes many imperfect cones in the axils of the permanent bracts." It is highly probable that the fertilization of the female flowers is effected by insects, as it appears "that a pollen-feeding group of Coleoptera, the Cetoniæ, abound in the regions inhabited by Welwitschia."

The season of the flowering and fruiting of the plant has not been accurately determined, inasmuch as it was found in

flower by Dr. Welwitsch in the month of September, and with ripe cones by Mr. Baines in the month of May.

From careful microscopical examination and comparison of parts, Dr. Hooker places this most extraordinary plant in the natural order Gnetaceæ, and considers it to have a very close affinity with the genera Ephedra and Gnetum.

Independently of its high scientific interest, the Welwitschia is valueless. There is no part of any economic use. Its leaves are tough, but leathery, and not softly fibrous, and therefore not adapted for cordage, weaving, or any similar use. Its trunk, though tough, is of such an uneven, fibrous grain, that the saw seems rather to tear it asunder than to cut it; and added to this, the general irregularity of its growth, it is no wonder that the plants have been allowed to grow on in their quiet, sandy desert-home, unmolested by the natives, and, in consequence, up to the time of its discovery, carefully hidden from the eye of civilized man. It is, however, one of the many proofs of the value of scientific explorations, which are happily becoming more appreciated in these days.

A NEW SPECIES OF CICADA, FROM THE CASCADE MOUNTAINS.*

BY J. K. LORD, F.Z.S.

I DISCOVERED this new and beautiful Cicada for the first time on the banks of the Pend-orielle River, on the eastern slope

* Order, *Hemiptera;* Sub-order, *Homoptera;* Fam., *Cicadidæ;* Genus, *Cicada* (Linn.); Nov. Species, *Cicada occidentalis* (Walker).

Sp. ch. Nigra subtus, albido tomentosa, facei et prothorace, testaceo marginatis, mesothorace lituris duabus cuneatis, lateribus margineque postice testaceis, segmentorum abdominalium, marginibus posticis subtus luteis, femoribus tibiisque testaceo vittatis, alis vitreis, basi rufis.

Cicada. Black under side, with shining whitish tomentum; head much narrower than the prothorax; transverse furrow in front testaceous; face transversely ridged on each side, with a testaceous border; prothorax with four oblique furrows, which converge hindward; border testaceous; sides with slightly gilded pubescence, dilated and rounded hindward; mesothorax with two V shaped testaceous marks, which extend from the fore border to the disk, and are indistinct except at the tips; sides and hind border testaceous; abdomen thinly clothed with shining whitish pubescence; hind borders of the segments luteous on each side and beneath; dorsal opercula testaceous; sheaths of the ovipositor greenish; femora and tibia with testaceous stripes; fore femora incrassated, with two teeth on the under side; wings vitreous, bright red at the base; veins black, greenish towards the base; fore wings with a greenish costa; first and second transverse veins slanting outward—first parted by more than twice its length from the second, third and fourth slightly slanting inward. Length of the body twelve lines. This species is smaller than *C. septendecem*, to which it has much general resemblance.

of the Cascade Mountains. Having fully indulged myself with a look at the scenery and a rest, after an early morning ride, I wandered off in pursuit of anything new and curious that might chance to fall in my way. Striking in among the trees, and following a deer trail for a short distance, I emerged suddenly on an open glade, or, more aptly, it may be said to have resembled an English meadow. The waving grass looked temptingly green, and peeping from amidst it were wild flowers of various species; a tiny stream, too, clear as crystal, twisted its way in many a bend and turn through this fairy spot. No human voice, perhaps, had ever disturbed its silence, but the song and twitter of birds, and the incessant hum of insect life, proclaimed at once that bush, flower, tree, rock, and lichen-clad boulder, each blade of grass, even the rippling stream, was the haunt, home, and lurking place of some living wonder.

But there was one sound—song, perhaps, I had better call it—clearer, shriller, and more singularly tuneful than any other, which never appeared to cease, and came from everywhere—from the tops of the giant pine and cedar trees, from the trembling leaves of the cotton wood, from the stunted under-brush, from the flowers, the grass, the rocks and boulders, yea, the very rivulet was vocal with these hidden minstrels, all chaunting the same refrain. It was the first time I had heard this song in north-western wilds, and although the singer was invisible, I knew it must be a cicada. A little vocalist was soon pounced upon and captured in his leafy orchestra.

Cicada Occidentalis, New Species.

He was a handsome fellow, with large bright shining eyes, and wings resembling the most delicate gauze, coloured green, and veined, like the leaves he loved to sit on. Having captured the *minstrel*, which is always the male—the female being destitute of sound-producing organs—the next thing was to commence a rigid search for female, pupa, larvæ, and eggs. The females were soon discovered clinging to the branches of the trees, some depositing their eggs, others idling amongst the foliage. They differ slightly from the males, in being less brilliantly

coloured, rather smaller, and provided with a long ovipositor, and in the absence of a sound-producing apparatus.

Turning back the long grass that grew under the shadow of the trees, lots of round holes were revealed—tortuous and winding as they deepened—and lined with a material like hardened glue, serving to preclude the access of any moisture; the greater part of those examined were generally empty; but in a few was the pupa of the cicada, quite close to the exit, or mouth of the hole. Deeper mining, aided by pick and shovel, unearthed the larvæ. I had now discovered all the family, and placing the respective living members, together with the unhatched eggs, collected from the branches of the trees, under gauze, commenced doing the detective. The situation was most convenient, and well adapted to this kind of inspection, as our depôt camp was near, and many months would have to be passed at it.

The pupa I obtained by cutting out large squares of turf and mould, in which were the holes; the larvæ, when dug up, were placed in loose earth, and supplied with fine rootlets to feed on. It will facilitate description to commence with the pupa, tracing it to the perfect insect, then how the eggs were deposited and hatched, and, lastly, what were the future proceedings of the larvæ.

When approaching maturity, the pupa remained near the surface,coming frequently to the mouth of the hole to sun itself, and get a taste of fresh air; the slightest noise, a breeze of wind, rustling the grass, a heavy cloud obscuring the sun, or a shower of rain, was quite sufficient to send it to its retreat. The pupa was in colour a yellowish brown, half cicada, half grub; the wings quite apparent, folded beneath the horny covering; the head and eyes much the same as in the mature insect. In from three to four days a few of them left their holes, and crawled up the dead branches placed in their prison (this was always accomplished during the night). As the sun shone upon the skin of the pupa, it changed into a semi-transparent condition, becoming very much lighter in colour, and in a short time, split down the entire length of the back. From out this sarcophagus crawled the winged insect; the wings damp and crumpled, and the body soft. Flowers were given them; but a sponge saturated with sugar and water, was readily and greedily sucked in preference.

Ten days passed away, and no song was attempted, and my fears were aroused lest captivity had broken the spirits, of these forest minstrels; but the real cause was soon apparent, another change of skin had to be accomplished. This was managed much in the same manner as the first shift, but attained with greater difficulty. The moisture gradually

evaporated between the body and the old skin, which at last cracked, as in the pupa, and through the rent, the whole body, wings, legs, and antennæ were drawn from their separate cases; then bidding good-bye to its old habitation, it crawled off, leaving its deserted skin clinging to the branch where the struggle took place.

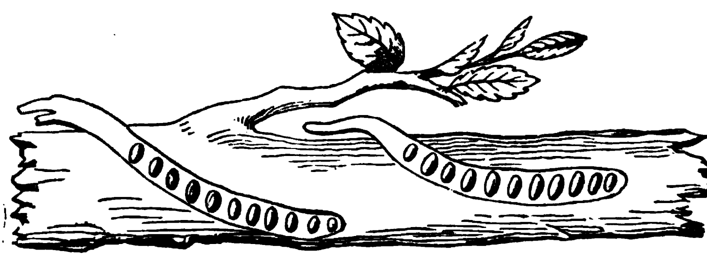
A very few days sufficed to show that the insect had attained its perfect form; the male commenced singing, and soon chose his silent wife.

The most distinctive character of this group of insects is found in the peculiar structure, by which the male is enabled to execute the shrill, prolonged, and singular music that was so prized by the ancients. These organs are situated at the base of the abdomen, and covered by two large flat plates, attached behind the place of insertion of the hind legs, but varying in form in different species, "being, in fact, the dilated sides of the metasternum" (West. Cl. In.). It is in reality a very beautifully-contrived musical instrument; there are drums and sounding-boards, with strings as tight and elastic as those of a banjo. There is also an air sac on each side of the intestinal canal, which is inflated by the opening and shutting of the wings. Connected with these sacs are valvular appendages, over which are stretched pieces of membrane, much like the skin of a banjo. The wings are always kept vibrating rapidly whenever the insect sings, striking against the drums; air at the same time being forced through the holes, or stomata, at the articulation of the wings, from the air-sacs previously spoken of —a veritable organ-pipe and bellows. Watching the cicada, whilst a prisoner, it was curious to observe its movements, prior to commencing its song. First of all the wings were opened and slowly shut, to inflate the air-sacs; then followed a gentle, vibratile movement of the wings, that increased in rapidity until they were hardly perceptible to the eye, producing the shrill song, or noise, so difficult to describe, save that it is a jubilant, joyous song, indicative of intense delight.

The eyes of *C. occidentalis* are large, prominent, and red like a ruby: between these larger eyes are three smaller ones, placed in a triangle; the antennæ six jointed; the sucker for extracting the juices of flowers composed of four pieces that form a tube, in this tube is the tonguelet, altogether a most efficient pump. Nothing can be more beautiful, or more wonderfully adapted to its purpose, than the ovipositor of the female. The instrument is concealed in a groove in the last ring of the abdomen, protected by a sheath, and consisting of three pieces. On either side are the files, on each of which are nine large teeth; at the ends, four smaller ones. The files are scooped and hollowed out, so as to fit, and work closely into the grooves,

in the central piece on each side. They are capable of being moved in any manner, separate or together, as the insect wills, the centre piece being always a fixture. The instrument is highly polished, and it is difficult to imagine that it is made up of distinct pieces, so admirably do they fit, and so rapidly is the work performed. The handles, if I may so name them, of these files, being composed of horn, afford a fixed and solid attachment for the muscles, that cause the files to be pressed closer and firmer to the centre-piece while in the act of sawing.

When the time arrived for depositing her eggs (about fourteen days after the final change), the female selected a branch from which the sap had commenced to dry up, or, in other words, which would soon decay. I observed this mode of selection more in the open forest, than during the insect's imprisonment. She first clasps the branch both sides with her legs, and with the end of the file very carefully slits up the bark, then placing the instrument longitudinally, files away, until she



Nest and Eggs of Cicada Occidentalis, magnified.

has obtained sufficient length and breadth. The *small* teeth of the files are now used crosswise of this fissure, until a trench is made in the soft pith. When large enough, slowly down the groove in the centre of the instrument glides a small, pearly egg, pointed at both ends, and so transparent, that the little grub within is easily discernible. Gently she lays it within its bed, and then drops a thin gummy material on it, to secure it from moisture. This finished, she proceeds to deposit another, and so on, until a sufficient number are produced to fill the fissure; then over all she drags the everted bark. It is easy to perceive where the cicada has been concealing her brood, by the elevations on the branch. In this manner she deposits about seven hundred eggs, going from branch to branch, her marvellous instinct teaching her to select the most suitable wood for the purpose. The time occupied in constructing each nest was from fifteen to twenty minutes. Her earthly

mission finished, she drops fainting and exhausted from the branch, and dies.

The male, who is always trilling his refrain, goes on indifferent, or unconscious, that the task of his faithful spouse is finished, singing ever, until his time comes, then he, too, drops beside her. Thus the songs, one by one, cease, not only the cicada's, but all the forest choir, and give place to the winter blasts, that sigh in mournful music through the leafless trees. These winds tear from the trees the decaying branches, which the instinct of the insect proclaimed were dying months previous. From the nests that are in these fallen branches, it is easy for the grub, the larvæ of the cicada, to bury itself in the earth, its future home; but those that come out whilst the branch remains on the tree, have to make a perilous descent. Fifty to sixty days from the time the eggs were deposited, there emerged an ugly little yellowish grub, covered with soft hair, lively and bustling; pinkish eyes, its feet armed with claws; if on the tree, they rushed directly to the end of the branch, and, without any apparent fear, precipitated themselves recklessly to the ground, where, without loss of time, they commenced digging. Their fore legs, shaped somewhat after the fashion of a mole's, enable them to turn up the ground with great expedition, ten to twelve seconds being long enough for one to get entirely out of sight. How long they remain in the larvæ condition I am unable to say.

It is a wise provision of nature that the cicada should produce such a numerous offspring; for their enemies, ever ready to pounce upon and destroy, not only the mature insect, but the eggs, larvæ, and pupa, are legion. Ants are untiring in their search for the cicada's eggs, and I have constantly observed them coming down from the trees, carrying the eggs in their mouths. Moles, too, eat the grubs during their terrestrial existence, and the brilliant Oriole, in his livery of orange and black, hunts for the insect under the leaves, nips it with its sharp beak, and descending to the ground, picks it to pieces, and, like a dainty epicure, swallows only the choicest morsels.

The Louisiana tanager seizes and gobbles him up bodily, crafty woodpeckers and stealthy little flycatchers pounce upon him in the midst of his song, and finish his life ere it is well begun. It is just possible that the female is voiceless, so as to insure greater security against the risk of capture whilst depositing her eggs.

Westwood tells us that of 150 species of cicadæ at the Royal Museum at Berlin, 70 are from America. One of the most singular of these is the *Cicada septendecem,* so named from a supposition that it only makes its appearance

once in seventeen years, a statement, the accuracy of which I am much disposed to question. All the known species of cicadæ, without an exception, as far as I know, spend only two years from the larvæ to the perfect insect, and it appears somewhat strange there should be a solitary exception to this apparently general law. Seventeen years seems an enormous time for an insect to remain in an immature condition underground. No one has ever kept the larvæ for that period of time; but because unusual numbers of cicadæ have been noticed as occurring at long intervals, it is at once assumed that seventeen years must have been spent in the larvæ state. I have never passed a summer in America without finding numerous specimens of this insect, the *red-eyed cicada*, as it is popularly styled.

The name *Cicada* is of somewhat doubtful origin. Beckman traces its derivation, *ciccum*, a thin skin; *ἄδειν*, a sound; then by others it is said to come from the Latin, *cito cadat*, short-lived, or soon to pass away. The Greeks named them *Tettix*, the French, *Chanteuses*, singers. By the Germans they are styled *Harper* (*Lierman*). Virgil, writing of the Cicadæ, deems their chaunt more loud than agreeable:—

Et cantu querulæ rumpent arbusta Cicadæ.

Widely different is the strain of a modern poet in reference to the celebrated Pineta, or Pine Forest, near Ravenna, where bards have wandered, and Cicadæ sung, from time immemorial. He writes:—

"The shrill Cicalas! people of the Pine,
Making their summer lives one ceaseless song:
There, the sole echoes, save my steeds and mine,
And vesper bells, that rose the boughs along."

BYRON.

Or, as an American writer suggests:—

"Perhaps the self-same song that found a path
Through the sad heart of Ruth, when sick for home
She stood in tears, amid the alien corn."

Homer, Virgil, Anacreon, and various ancient poets, have alike sung the praises of the Cicadæ. An Athenian banquet, without an *entrée* of Cicadas, was deemed as great a failure as would be, in these days, a Greenwich feast without whitebait. The larvæ and pupa were esteemed the greater dainties, but a female full of eggs, artistically browned, and served up hot and juicy, was a *bonne bouche* the Greek epicure well knew how to estimate. Even Aristotle thought the dish a luscious one, "*quo tempore gusta suavissima sunt,*" and at the present time cicadæ are regularly sold in the markets of South America. The legs and wings are stripped off, and the body

of the insect slowly dried in the sun. When sufficiently dry, it is powdered, and made into a kind of cake, and in that form sold and eaten.

In ancient poetry and fable constant allusion is made to the cicada. The Greeks even kept the male insect in cages for the sake of its song.

It was "the nightingale of the nymphs." Anacreon says, "the Muses loved thee, Phœbus himself loves thee, and has given thee a shrill song, old age does not wear thee out, thou art wise, earthborn, and musical." The following quaint fable singularly alludes to the cicada:—"Tithonus, the son of Laomedon, was loved by Aurora, who carried him to Oelos, thence to Ethiopia, and at last to Heaven, where she prevailed on the destinies to bestow on him the gift of immortality, but forgot to add that of youth. At last Tithonus grew so old that he was obliged to be rocked to sleep, like an infant, when Aurora transformed him into a cicada, which retains its youth by changing its skin, and in its chirping retains the loquacity of old age. So also we read that Eunomus and Ariston, rival musicians, were contending against one another, each played the harp, and it was hard to say which was the better player, when crack went a string from the harp of Eunomus, a cicada pitching on the top of the instrument supplied the place of the broken string, and so effectually, that Eunomus was declared the victor.

OUR FUTURE COAL FIELDS.

BY JOHN JONES, F.G.S.,

Secretary Dudley Geological Society.

It is barely three years ago since Sir William Armstrong, in his presidential address at the Newcastle meeting of the British Association, startled the commercial community in general by his allusions to the speedy exhaustion of our British coal fields, and to the rapid approach of a period when our whole manufacturing activity must be paralyzed, or must depend upon foreign supplies of coal. The Government surveyors and other practical geologists have mapped out, with minute accuracy, almost every inch of ground belonging to that part of the great geological series known as the Coal Measures, and the number and value of the various mineral seams peculiar to each district have also been clearly ascertained.

Under these circumstances, it seems no difficult problem to determine the utmost limit of our resources of coal and

ironstone. A certain portion of each coal field has been exhausted; the produce per year is so many tons, and is constantly increasing. From these data the duration of the minerals known to exist beneath any given surface can be easily estimated with tolerable precision. If then, the calculations of so eminently practical a man as Sir W. Armstrong should be thoroughly reliable, and not overdrawn, we naturally ask what will become of the principal manufacturing industries which now contribute so largely to our national wealth and prosperity?

There is no fear that any dearth of fuel will be felt in our day, even should we have to depend entirely upon the known coal-producing areas; but if no new tracts are opened up, our descendants will, at no distant date, have to cope with a coal famine, which will speedily drive some of our most important manufactures into other localities. These were considerations which the address above-mentioned did most certainly excite in the minds of not a few practical men, and hence, since the last meeting of the British Association at Newcastle, a great amount of careful attention has been devoted to all questions by which the duration and probable extension of our coal-fields would be elucidated. The result has been the accumulation of many interesting and valuable facts, especially relative to the circumstances under which the numerous isolated coal tracts in this country were formed, and received their present configuration. A close relationship has been traced between several of these districts, and it has been pretty clearly demonstrated that a considerable portion of the Carboniferous formation is now obscured by newer deposits. To enter into details respecting all that has been done in this particular line of research would exceed the limits of this paper; but the subject is one of such national importance that we would briefly notice a few of the conclusions which have been drawn, or more fully established, from the investigations of the past few years.

In the first place, it is now the generally received opinion that all the Northern and Midland coal-fields belong to the same geological period, and were deposited originally in one extensive area, local causes producing variations in the character of the vegetable remains, in the extent of the several coal seams, and in the thickness of the intervening beds of sand and clay. This large carboniferous estuary or lake was afterwards strangely dislocated by the igneous action which produced the long line of mountain limestone and millstone grit hills now forming the Pennine range, or the backbone of England. In the gradual elevation of this central portion of the basin, the coal measures overlying the limestone would be

removed by the action of the water, while those same deposits would be only slightly affected in places remote from the centres of igneous activity, except, perhaps, to get an additional layer of matter from the denudation of the beds where elevation was progressing.

This period was succeeded by that in which the lower New Red deposits, or Permian rocks, were formed upon the edges of the coal measures. A still further obscuration of the coal would take place during the Triassic and Liassic periods; so that, doubtless, previous to the time when the Oolite was deposited, the whole or greater part of the present Northern and Midland coal-fields were completely hidden beneath a great thickness of superincumbent material. Igneous action again came into operation, and elevated particular tracts, and the Red Rocks were completely carried away by denudation, leaving large areas of Upper Carboniferous rocks exposed.

Such is a brief history of the coal-fields stretching at intervals from Fifeshire into the central part of England. Assuming then that these coal-producing areas were once connected, and that this connection still remains intact, though obscured by later formations, attention has recently been turned to the probable thickness of the Red Rocks which form the large and fertile agricultural plains of Cheshire, Shropshire, Staffordshire, and other parts of central England. Compared with these tracts, the existing coal-fields shade into insignificance, and the bare prospect of successfully following the known coal-seams beneath the Permian and Triassic systems opens up such fabulous dreams of wealth, that it is difficult to contemplate the possibility of so much good fortune with equanimity. Notwithstanding the rapidly increasing rate at which we are exhausting the coal measures of Northumberland, Yorkshire, Staffordshire, and Lancashire, we have good reason to believe that there are greater treasures in store than we have yet extracted. In the north, several mines have been sunk through the Permian beds, and coal of excellent quality has been obtained. On the western side of the Warwickshire field, similar experiments have been successfully made. The Permians adjoining South Staffordshire have been proved to over-lie the famous ten-yard seam of that coal-field. On the western border of the Coalbrookdale district, the Red Rocks have been sunk through, and coal has been found. The same has been done in Derbyshire and other places, and hence it may be considered as an established fact that we may regard the Red Sandstone plains of central England as only one great but obscured coal-field, which at no remote period will be studded with mining appliances, and will be busy with all the concomitants of a vast manufacturing district. The problems yet

to be solved are mainly these:—First, what is the maximum thickness of the Permian and Triassic systems in the districts above mentioned? At present this has not been at all accurately made out, though it is a matter of the greatest importance in arriving at a reliable estimate of the difficulties to be encountered in mining the underlying coal. In the second place, we still require additional evidence upon the precise increase of temperature which prevails at depths of from one to two thousand yards. Having due regard to the advances which have been made in our knowledge upon these points during the last few years, we may reasonably hope that in proportion as the attention of scientific men is directed to these investigations, we shall have reliable data laid down upon which the practical solution of the existence of coal underneath the tracts indicated will be easily determined, and, if discovered, will be worked with facility, though not at so cheap a rate as the mineral which lies nearer to the surface.

The immense importance of these questions is now fully admitted, especially in the Midland and Northern counties, for there some of our most important and most extensive manufactures have been established. The great hardware "village," where everything metallic is made, from a trinket to a ponderous steam-engine; the adjoining Black Country, with its extensive manufactures of iron; the potteries of North Staffordshire; the textile fabrics made in Lancashire and Yorkshire; are all dependent in a high degree upon the coal which has long been obtained close at hand. With the prospect of further supplies, which may be regarded as almost exhaustless, those manufactures will still retain their ground, nor will they show any tendency to migrate towards the West, or to any other shadowed home of future civilization and human enterprise. Of course there are numerous elements of uncertainty which ought to be taken into account when endeavouring to estimate the probable existence and value of coal measures underneath the Triassic rocks. It is just possible that the coal seams may thin out over large areas, or denudation may have removed all the upper coal measures during the interval between the close of the Carboniferous and the commencement of the Permian periods, though it is not unlikely that this latter contingency has been considerably overstated.

We may take it for granted that the mineral resources of our island are not yet even approximately known. The last quarter of a century has been exceedingly prolific in important discoveries of our natural wealth. The Northampton and Cleveland iron ores; the phosphatic deposits of North Wales, Cambridgeshire, etc.; the hæmatites of various places; and the extension of the coal-producing areas, are recent additions

to our national wealth, and we have no reason to conclude that we have exhausted our discoveries. To the rapid advancement of scientific investigation we owe nearly all that has been done in the above direction during the last few years, and we may therefore regard with confidence the researches which are still in progress. The time is, doubtless, fast approaching when the principles of natural science will be much more generally appreciated than is now the case; and if any illustration of the great practical value of such knowledge were required, it would surely be sufficient to point to the line of reasoning by which the area of our future coal fields is being now mapped out, and by which we may reasonably expect our national prosperity will be immeasurably developed.

HOT SPRINGS, AND OTHER NATURAL FEATURES OF THE PYRENEES.

BY A. S. HERSCHEL, B.A.

Covered with a dense mass of snow, shaken with avalanches, and torn by tempests in the winter, the mountain chain of the Pyrenees no sooner recovers from its stupor, and clothes its pastures with summer green, than tourists climb its heights, ascend its plateaux, scale its lofty crags, and seek and find health and recreation among its recesses. It is not, however, to guide the reader in these scenes, but rather to describe some of the natural features of the mountains, to be found in a summer ramble among the Pyrenees, that the following few short notes are written.

Geologically speaking, the central range of the Pyrenees is a ruined wall with peaks, chiefly granite, upheaved to a height of ten or eleven thousand feet above the sea, between the low-lying plains of Languedoc on the one hand—intersected here by a canal from the Mediterranean to the Atlantic Ocean—and the high table-lands of Castile and Aragon on the other. From the spinal column of this chain, lateral spurs, like rib bones, are thrown out on either side towards the plain, composed of calcareous and other sedimentary rocks, coëval with our Greensand series, horizontally deposited, and afterwards broken up, distorted, and raised to their present elevation by the force of internal pressure. The tertiary strata at the foot of these rocks reach only to a height of a few hundred feet, and are on all hands horizontal. Extensive lower valleys between these natural buttresses branch out at their heads

into narrow ravines, leading by "ports" or mule-tracks into Spain. Others end in a natural *cul-de-sac,* called a "cinque," surrounded on three sides by lofty walls of rock, and entered by a narrow gulley from the valley on the fourth. At the head of the lower valleys lie the celebrated Pyrenean "spas," a few of which also occupy higher and cooler situations in the gorges. From valley to valley the ridges are crossed by "cols," generally lofty, and wild in their scenery—often diversified by cascades, or even by snow-drifts and mountain-lakes.

In these hill-fastnesses the box-tree is one of the most common forms of shrub, and there exists an abundant variety of wild-flowers, more like our own British flora—apparently from the neighbourhood of the Atlantic Ocean—than those met with in the more continental valleys of the Alps. A collection of specimens procured, and dried in August, 1865, occurring high and low in the Pyrenees, west of the Adour, presents us with an exactly equal proportion of British and foreign species. Those of our readers who study the pages of Linnæus and De Candolle, will meet with many familiar acquaintances in the following list:—

BRITISH SPECIES.

Common Clematis, *Clematis vitalba.*
Yellow Welsh Poppy, *Meconopsis Cambrica.*
Grass of Parnassus, *Parnassia palustris.*
St. John's Wort, *Hypericum.*
London Pride, *Saxifraga umbrosa.*
Yellow Mountain Saxifrage, *Saxifraga aïroïdes.*
Field Eryngo, *Eryngium campestre.*
Heart-leaved Valerian, *Valeriana Pyrenaïca.*
Sheep's-bit Scabious, *Jasione montana.*
Michaelmas Daisy, *Aster trifolium.*
Common Marjoram, *Origanum vulgare.*
Common Butterwort, *Pinguicula vulgaris.*

FOREIGN PLANTS.

Adonis, *Adonis Pyrenaïca.*
Alpine Columbine, *Aquilegia alpina.*
Horned Violet, *Viola cornuta.*
Alpine Pink, *Dianthus superbus.*
Silver-leafed Geranium, *Geranium argenteum.*
Broad-leafed Scabious, *Knautia sylvatica.*
Gentianella, *Gentiana acaulis.*
Viper's Bugloss, *Echium.*
Alpine Toadflax, *Linaria alpina.*
Great Self-heal, *Prunella grandiflora.*
Knot-flowered Vervain, *Verbena nodiflora.*
Auricula Primrose, *Primula auricula.*

Corresponding to the great variety of flowering plants, there is also in the Pyrenees a considerable variety of climates. At the heads of valleys between Bagnères and Pau, the well-known towns of Eaux Chaudes, Eaux Bonnes, Arrens, Barèges, St. Sauveur, and Ste. Marie, are all less than three thousand feet above the sea. Here peaches, maize, and flax reach their limits, and the vine is no longer cultivated. Above them, Gabas, Cauterets, Gavarnie, and Aragnouet, occupy the heads of gorges, at an altitude of about four thousand feet. Apples and pears arrive at maturity, oats and barley are cultivated, and eyebright, London Pride, and other familiar British flowers, are found upon the slopes. Upwards from this height to about seven thousand feet, a cloud-stratum usually occurs upon the hills, crowned with fir-forests, and at this point cultivation ceases. The banks of columbines, blue-bells, and wild mountain-pinks are left for pastures to the flocks and herds, which are guarded by a very ferocious breed of dogs. The cloud-stratum passed through, the traveller, aloft, finds himself once again in the brilliant sunshine, with the level of eternal snow around him, at an altitude of nearly nine thousand feet above the sea. Vivid-coloured iris, gentianellas, saxifrages, and other hardy flowers, at the greatest elevations, face the blinding rays of the sun, and the keen air from the surrounding snowy heights. Lammergeiers here assemble in flocks. Six of these birds were counted together, at sunrise, from the Pic du Midi de Bigorre; and one rose within gunshot before us, from the rocks on the summit of the Col du Vignemale. An ornithological fact may also be mentioned here, not altogether unconnected with the fauna of the Pyrenees. A cuckoo, evidently exhausted with its autumnal migration, was caught by hand in Jersey, on the 4th of August; and a second, equally exhausted, narrowly escaped capture in a similar manner, at Eaux Bonnes, on the 14th of the month. This probably indicates that there is a definite time for these birds to emigrate—about the first week in August—as well adhered to as that of their arrival in April.

Slight shocks of earthquakes are occasionally felt in the Pyrenees, which, although never very violent, occur at all seasons of the year. One, felt at Eaux Bonnes, and at Bajez, in the Val D'Ossau, at five o'clock on Sunday morning, the 13th of August, was not perceived at Argeles, nor at Bagnères de Bigorre, although these towns are no great distance from Eaux Bonnes. The phenomenon of earthquakes in the Pyrenees appears to be connected with the erosive action of water on the marble rocks of which a part of the range is composed, as well as with the thermal springs, of which the name in these mountains is truly legion! The town of Ax (or "Eaux," from

which the name is derived), in Ariège, numbers no less than eighty-four of these hot springs, the hottest and most copious of any in the Pyrenees. A few, like those at Bagnères de Bigorre, are purely saline. The majority are impregnated with sulphuretted hydrogen, a gas easily decomposed by contact with the air, and depositing a precipitate of sulphur, called "barégine," in open channels near their sources. The spring at Moudang contains protosulphate of iron, by which the waters preserve their sulphurous character for some time; and the waters of this spring and of a few others are exported.

The average temperature of thermal springs in the Pyrenees is more than 100° Fahrenheit, well adapted for therapeutic purposes in every variety of baths, douches, etc. The vessels for these baths are generally made of the marble of the country. That the hot springs were known to the early Romans, and were by them used for this purpose, is apparent from recent excavations at Bagnères de Bigorre, where baths have been discovered more extensive than any there existing at the present day. The question, if these thermal springs have preserved a constant temperature after the lapse of so many centuries, is one of some interest in connection with the geology of the chain. As long ago as the year 1835, Professor Forbes, of Edinburgh, specially examined their temperatures with a view to discover if any variations could be traced in a moderate number of years. In the interval now elapsed, of thirty years, many careful observations have been made, but no permanent variations have been brought to light. The most recent series of observations with which we are acquainted is that by Dr. Scoresby Jackson, in August, 1863, described in vol. xxiii., part iii., of the *Transactions of the Royal Society of Edinburgh*. By Professor Forbes the waters were examined at their source, or "griffon," as it is termed, of the spring, where the waters issue from the rock. They are conducted thence by means of various channels to the different parts of the thermal establishments, as douches, baths, etc., and to the "buvettes," which are the public fountains, where persons ordered for their health to drink the waters are supplied. At this spot a thermometer placed for a few minutes under the constantly-flowing stream, records the temperature of the water at the buvettes; but not by any means its temperature at the griffon, which is often a considerable distance from the buvette. As the rock is from time to time explored, and the buildings are improved, alterations at both sites are occasionally made. The constancy of temperature at the buvette is, however, in general, as remarkable as at the griffon of the spring itself. In Dr. Scoresby Jackson's experiments the temperatures were recorded at both places. At whatever point

of the spring the temperature of the spring is taken, the point at which the thermometer is inserted should always be accurately noted.

The instrument with which the following observations were made in August 1865 was a Centigrade thermometer, constructed by one of the best makers in Paris. The total length of the thermometer was about six inches, and the stem was engraved with sixty-six centigrade degrees. The extremity of the tube being turned into a ring, to which a cord was attached, the instrument could be completely immersed in tumblers, etc., at the springs. The words, "Rectifié, No. 795," are engraved upon the stem, and also the name and address of the person at Pau through whose kindness I received the loan of the instrument, for the purpose of making these experiments. Plunged in melting snow, and afterwards in running water in a crack of the Glacier du Vignemale, the mercury always marked within a tenth of a degree the zero of the Centigrade scale. Placed by the side of a standard thermometer in cool spring water at the residence of Mr. Maxwell Lyte, at Bagnères de Bigorre, the mercury in both instruments stood at 13° Centigrade. From these observations, and from the sensitive character of the instrument itself, it is assumed to have been free from errors of graduation. A small additive correction of between one and two-tenths of a degree Fahrenheit, for index-error, has been left out of account in the following tables.

Temperatures of five thermal springs at Cauterets in 1835, 1863, and 1865.

Name and point of Spring observed.	Temperatures, in degrees, Fahrenheit.				
	August, 1835.	August, 1863.	August, 1865.	Increase.	Decrease.
	°	°	°	°	°
La Raillière, griffon......	101·90	101·80	...	...	0·10
Ditto buvette.......	...	101·30	101·27	...	0·03
Manhourat (en haut), buvette	121·70	121·00	120·35	...	0·65
Les Oeufs, griffon	130·10	131·00	...	0·90	...
Ditto escape	...	119·00	120·17	1·17	...
Pauze vieux, griffon	110·30	109·75	...	...	0·55
Ditto buvette......	...	102·30	102·35	0·05	...
César (en haut), griffon...	118·10	117·40	...	...	0·70
Ditto, buvette	...	116·30	115·85	...	0·45

For convenience of comparison with the earlier observations, the indications of the Centigrade thermometer, No. 795, are

rendered, in this and the following tables, according to the ordinary rule of conversion, by their equivalents in the Fahrenheit scale. The correction of between one and two tenths of a degree Fahrenheit, to be applied additively for the index-error of the instrument, would, in general, bring the observations in August 1865 into closer coincidence with those of older dates than those already given in the table.

The spring called "Les Oeufs"—from the strong odour of rotten eggs that it emits—is the fullest, hottest, and strongest of all the springs at Cauterets. It is proposed to conduct it into the town, a distance of more than a mile from its actual source; one-half of which distance has been accomplished, and the spring now escapes from its tube by the road-side, near the Point de la Raillière. This point is apparently the point of escape described by Dr. Scoresby Jackson in 1863, and the temperature appears to have risen one degree.

The variations noticed at these springs at Cauterets in thirty years are small and insignificant when their generally high temperatures are considered. Equally small changes occur in six springs at Barèges, and at Bagnères de Bigorre, observed in August 1863 and 1865. The spring of the Platane, at Bagnères de Bigorre, of which the reservoir, or griffon, is exposed to the air, exhibits from this circumstance a somewhat more considerable alteration.

Temperatures of certain thermal springs at Barèges and Bagnères de Bigorre, in 1863 and 1865:—

Name and point of Spring observed.	Temperatures, in degrees, Fahrenheit.			
	August, 1863.	August, 1865.	Increase.	Decrease.
	°	°	°	°
1° at Barèges	...	...	...	...
Tambour, buvette	109·10	109·37	0·27	...
2° at Bagnères de Bigorre	...	...	...	...
Platane, griffon	92·30	90·29	...	2·01
Foulon, griffon	95·00	94·97	...	0·03
La Reine, buvette	110·40	109·37	...	1·03
De la Montagne (Salut) griffon	89·00	90·11	1·11	...
De l'Intérieur (Salut) buvette	87·80	88·13	0·33	...

In the establishment of the Salut, the griffon of the "Source de la Montagne," is a horizontal gallery, driven several yards into the rock, in the floor of which the spring,

not large but deep, rises to the surface through a natural chasm in the rock. The water is conducted to the establishment, near the spring, with the least possible loss of temperature, by subterranean tubes. At the "Source de l'Intèrieur" the buvette is not more than a yard from the actual source, which is an oval recess, excavated to a depth of three feet in the rock. The normal condition of this spring, like the rest of those at Bagnères de Bigorre, is saline, but at irregular intervals it becomes sulphurous. The volume of the water at the same time enlarges. It is supposed, in explanation of this property, that water of infiltration from the surface soil, carrying with it organic matter, enters the spring, and, aided by heat, effects the decomposition of sulphate of lime and other mineral sulphates in the water, from which sulphuretted hydrogen is evolved. Alkaline sulphides, particularly sulphuret of calcium, occur among the forms in which sulphur is found in the Pyrenean springs.

At Eaux Bonnes, and at Eaux Chaudes, some interesting traces of variation are found in the observations of Professor Forbes and Dr. Scoresby Jackson. The notes of other observers tend to show, however, that these changes are not permanent, the temperatures of these springs having fluctuated several times during the short interval of thirty years, to the extent of two or more degrees. A hot spring, employed at Ax as a street fountain, has, moreover, preserved its high temperature, with only a small range from 166° to 169° Fahrenheit, unchanged for eighty years.

M. Filhol, the Head of the College of Medicine at Toulouse, who has devoted much of his personal attention to the subject, believes that, in general, springs of a high temperature are less susceptible of variations than those of a low temperature. This might naturally be expected to occur from the fact that the hottest springs have probably also the deepest source; the cooler springs, rising probably from a smaller profundity, and belonging to more permeable strata, are more exposed on this account to infiltration. In this group of variable springs, M. Filhol has observed that, with a change of temperature, there is generally a corresponding change in the volume of the water, a lower temperature being observed with an increase in the abundance of water. Nevertheless, M. Filhol has found that the temperatures of springs —even those best regulated, and most protected from water of infiltration—*is not absolutely invariable.* A diminution of temperature is sometimes observed with a diminution in the volume of the water.

Dr. Scoresby Jackson carries his conclusions further. He admits that there is perhaps, in no instance, an undevi-

ating temperature, yet he believes that the temperatures of these springs in the interior of the globe have undergone no change.

Thermal springs, it may be presumed, are caused, like other sources, by water entering the fissures of the earth at a high point, conducted thence by channels in the manner of a syphon, and seeking its issue at a lower level. Their high temperature—it has been maintained by Dr. Bianconi at Bologna—is produced by the friction of the water as it passes through its rocky channel. It may also be supposed to arise from the high temperature of the low strata of the earth into which their channels descend. If either of these suppositions is correct, the power of conducting heat that the rocks possess through which they rise must exercise a considerable influence on their temperature, in consequence of which a diminution of temperature will generally be found to accompany a diminution in the volume of the water. A diminution of temperature will also occur with an *increase* in the volume of the water, if cold surface water should, by any chance, find its way into the spring. In this way all the fluctuations of temperature and volume so frequently observed may be accounted for, without resorting to hidden agencies in the interior of the globe to explain the variations of these thermal springs. The words of Dr. Scoresby Jackson, with which he concludes his observations, appear to us to merit every attention when he says that, in these springs, "there is, perhaps, in no instance, a permanent change of temperature; but the changes observable upon the earth's surface are due to superficial and evanescent causes—such as external temperature, the infiltration of cold surface water, and the like." With these remarks we willingly leave the subject of the Pyrenean springs for the present in the hands of our readers, convinced that the inquiry in this branch of physical science, equally as in every other, will ultimately be attended with success.

A SUBSTITUTE FOR THE POSITION MICROMETER.

BY CHARLES GROVER.

[A STRONG interest attaches to the pursuit of science under considerable difficulties, and we therefore depart from our usual custom by saying a few words on the author of this communication. He is an artizan—a brushmaker—fortunately possessed of a two-inch telescope, and doing such good work with it as to have attracted honourable notice from Dr. Lee, of Hartwell House, Mr. Birt, and our own highly-esteemed contributor, the Rev. T. W. Webb, by whom this paper has been sent to us. The plan adopted by Mr. Grover is certainly ingenious, and may suggest to others, who, like him, cannot afford more perfect instruments, how much may be accomplished by ingenuity and perseverance. If a poor working man, subsisting and keeping a family upon slender weekly wages, can manage to make considerable progress in observational astronomy by the diligent employment of his leisure hours, what a wide field is open to those who can devote ample time and money to any favourite pursuit ?—ED.]

I have been greatly interested in observing the various double and binary stars, so ably treated of in your pages by the Rev. T. W. Webb, and have often wished (as I dare say many other amateurs have done) for some cheap and simple instrument for measuring their angular positions, that excellent instrument, the position micrometer, being, from its price, inaccessible to me.

After a good deal of thought, and the advice of one or two astronomical friends, I have devised and constructed an apparatus which on trial I found so useful that I have thought it worth while to send you a description of it, hoping it may prove acceptable to many of your astronomical readers.

The first thing to be done is to prepare a carefully-divided circle, of a size corresponding to the eye-end of your telescope. This may be of any suitable material, to suit the amateur's convenience. Mine is simply drawn on paper, and attached to the telescope with a little warm glue. If the telescope is of small diameter, the circle may be of larger size, so as to project all round; but then it becomes liable to be injured by contact with various objects.

As to dividing, large circles have the advantage of small ones, in giving more space for division, and crowded circles are difficult to read by the faint light allowed in the observing-room. Mine is but two inches in diameter—a size not large enough to allow of single degrees being shown on it well;

FIG: 1.

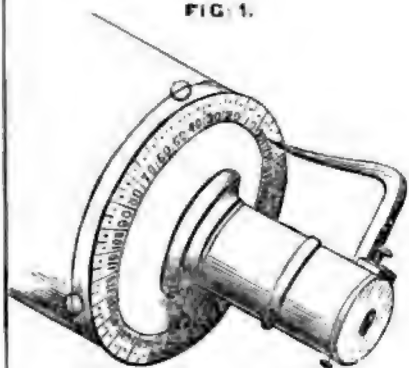


FIG: 2.

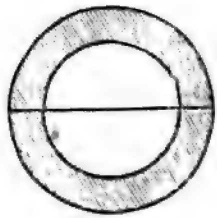


FIG: 6.

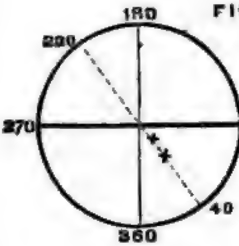
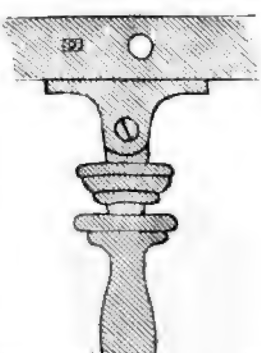


FIG: 3.

FIG: 4.



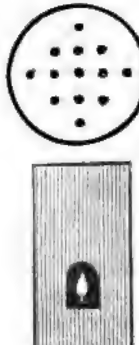


FIG: 5.

therefore it is graduated by long lines to every 10°, and shorter lines for every 5°, and by dots to 2½° (see Fig. 1).

This all-important part of the contrivance being duly attended, the index by which it is to be read next comes in for consideration. This is of steel. Its form will be more readily comprehended from the drawing than from any written description. It is attached to the eye-tube by the brass screw and nut, which is pierced with a slit lengthwise for its reception and adjustment, the length of the index being so managed that when the instrument is adjusted to focus, its point just reaches the circle. The screw on lower side of eye-tube is merely to assist in revolving the eye-piece.

Inside the eye-piece, in the focus of the eye-lens, I have fixed a perforated cardboard disc, the opening being rather larger than the aperture of the stop always placed there, and across the field a conspicuous wire is carefully placed (see Fig. 2).

Now to render this visible during observations it needs some illuminating apparatus, and I have used with advantage an oval reflector of bright tin, with a sufficient central aperture to allow all the rays from the object-glass to reach the eye unobstructed. This is fixed inside the tube, at an angle of about 45°, as shown in Fig. 3. The relative position of the screw, and the hole for admitting light, are shown in Fig. 4. This hole needs to be no larger than a sixpence, and should be just opposite the point *a*, Fig. 3. For a lantern I use a tin canister, about seven inches high, and two in diameter, with an opening in its side for light, and numerous perforations in the top for the escape of heat. Within this is a small paraffin lamp (see Fig. 5). The degree of light, and its distance and position with respect to the aperture in the telescope, will be better learnt by a few practical lessons than by any written instructions.

Having detailed the construction of the apparatus, we will now point out its use, and for this purpose we cannot do better than suppose a pair of stars in the field, as shown in Fig. 6. Now to measure their angle of position, revolve the eye-piece till the index is to the left side of the circle, and bringing the larger star to the edge of the wire, gradually revolve the eye-tube till the star in its motion through the field exactly traverses the wire. Note the degree indicated on the circle. This will be 270°. Now revolve the tube till the wire becomes parallel to the pair, and note the number of degrees it has turned, as from 270° to 220°. This is 50°; but as the smaller star is on the opposite side, the reading must likewise be transferred, and you must substract 50° from 90°, which leaves 40° for the angle.

As it is more than probable that there may be considerable errors of division in such a homely affair, it is best to take measures of an object in each of the four quadrants of the circle, as by so doing we, to a great extent, get rid of such error. Neither is it important that the points 0°, 90°, 180°, 270°, etc., should correspond to their proper places in the field, as if in the first instance just named, instead of 270°, the index read 140°, we should merely write 140°, 270°, and proceed as before. The angle made by a line joining the two stars, with the line of their motion through the field, is all that is wanted.

Professional astronomers may smile at the roughness of the contrivance; but to the amateur to whom expensive appliances are inaccessible, it will be found, when used with care and discretion, to be no mean help in the prosecution of his favourite science.

SOLAR PHYSICS.*

The physical constitution of the great centre of our system is a subject of the highest interest, not only to astronomers, but to all cultivators of natural science, and it must command the attention of all educated persons who may not specially devote their minds to scientific pursuits, just in proportion as the results arrived at admit of being placed in a popular form. England, France, and Germany are the three countries specially engaged in this question at the present time. In our own country, many private observers, like Messrs. Carrington, Lockyer, Nasmyth, Howlett, and others, have collected a highly valuable store of facts; while the Kew Observatory, taking up the previous private labours of Mr. De La Rue, has supplied, for the last two years, as far as the weather would permit, a daily record of the spots or other markings on the sun's surface which photography is able to preserve. In France, M. Chacornac works most industriously at Ville Urbanne, with—we believe—M. Foucault's large silvered glass telescope; but the *bulletins* which he is kind enough to send us do not specify either the instrument or the amount of aperture employed. We have already laid before our readers

* *Researches on Solar Physics*, by Warren De La Rue, Esq., Ph.D., F.R.S., Pres. R.A.S.; Balfour Stewart, Esq., M.A., F.R.S., Superintendent of the Kew Observatory; and Benjamin Loewy, Esq., Observer and Computer to the Kew Observatory. First Series, on the Nature of Sun-Spots. Printed for private circulation, by Taylor and Francis.

several accounts of his observations and speculations, and shall continue to do so, as they are of great value in indicating a very important class of facts, and in suggesting theories which, whether finally accepted or not, may be made of great use in suggesting particular lines of inquiry and observation. The Kew photographs, of which we gave specimens in vol. v., p. 450, afford admirable records of the appearance and disappearance of spots; but they are not intended as pictorial representations. M. Chacornac's figures possess this character, and so do the large drawings for which Mr. Howlett has won an honourable amount of fame. Several German observers contribute frequent papers to the *Astronomische Nachrichten*, and Schwabe's laborious observations, together with earlier observations by Professor Wolf, of Zurich, are amongst the materials at the disposal of Mr. Warren De La Rue and his coadjutors, who have just put forth the first series of their *Researches on Solar Physics*, of which we shall proceed to give an account.

The writers begin by remarking on the marked difference between the knowledge we possess of our luminary and of our satellite; and they say, "Could we imagine an observer suddenly transported to the neighbourhood of Tycho or Copernicus, he would probably be better prepared for the appearance presented to him than he would be if placed suddenly in equatorial Africa or central Australia." With the sun the case is different; for though the spectroscope enables us to detect the presence of certain familiar substances, the daily outpouring of solar light and heat remains a great mystery; and "it has not been finally decided whether this luminosity proceeds from the sun's solid body, or from an envelope which surrounds it. Indeed, so strange and unaccountable are many of the features presented to us, not only by our own sun, but by many of the stars, that it has even been conjectured that these bodies exhibit instances of the operation of some force of the nature of which we are yet ignorant."

In the history of solar physics, Galileo first attempted to make use of sun spots to determine the rotation of our luminary. After this, in 1777, Alexander Wilson, Professor of Astronomy in Glasgow, advanced the opinion, that the spots were cavities in a luminous photosphere. Schwabe, of Dessau, demonstrated, from forty years' observations, that "the number of spots which break out on the sun's surface is not the same from year to year, but has a maximum about every ten years—a remark which led General Sabine to observe that the various epochs of spot frequency were also those of magnetic disturbance in our own globe." To Mr. Carrington, the writers on *Solar Physics* ascribe the next important step. He

discovered that sun-spots have a proper motion of their own "those near the solar equator moving faster than those near the poles." Mr. Dawes has shown that the degrees of luminosity in the *faculæ*, or bright streaks, and spots, may be arranged as follows: 1, faculæ; 2, ordinary photosphere; 3, the penumbra; 4, the borders of the umbra; 5, the very dark central nucleus.

When the sun suffers a total eclipse, certain red flames or protuberances are noticed to surround his disc. Airy and Arago first ascribed them to the sun's disc, and "Struve showed it to be probable that these flames do not change during the moon's motion." During the Spanish expedition of 1860, Mr. De La Rue set this question at rest by showing from his photographic pictures that the moon's motion only affects these flames by covering one portion and uncovering another, and he likewise demonstrated that the angular motion of the flames corresponded with the theory of their fixation in the sun. Secchi followed De La Rue with the same results.

The "Willow Leaves" of Mr. Nasmyth are thus alluded to in *Solar Physics*:—"The evidence of these is still disputed; but some of our best observers in this country have seen them under very favourable atmospheric conditions, and they have been seen more frequently by Secchi, and other Italian observers." The important discovery by Chacornac of downward currents in the spots of which we have previously given an account, is then adverted to, as well as a similar observation by Mr. Lockyer.

In the Kew observations, reasons have been found for believing that the sun possesses an atmosphere exercising refractive power. They show the central portion of his disc to be more luminous than the borders. Kirchhoff and Bunsen's observations on solar spectra point to the same conclusion, and "the red flames which have been proved to belong to the sun indicate the existence of a solar atmosphere, extending in some instances as far as 72,000 miles above the photosphere. This is confirmed by the light which these flames emit. Mr. De La Rué has found that this light is very rich in actinic rays, so much so that he was able to photograph at least one protuberance not visible to the naked eye. Now it is precisely this description of light which characterizes the electric discharge, in which gaseous matter appears in a highly heated state."

The first question which the authors of *Solar Physics* attempt to answer is, whether the results of the observations at their disposal indicate that the umbra, or darkest part of a spot, is at a lower level than its penumbra. They give tables

analyzing many hundred observations, and show that the majority favour Wilson's supposition that the spot is a cavity with the umbra for its lowest part. Their second question is—"is the photosphere of our luminary to be viewed as composed of heavy liquid or solid matter, or is it of the nature of a cloud?" An investigation into the known appearances presented by faculæ lead them to believe that they, and indeed the whole photosphere of our luminary, are of the nature of a cloud, and they suggest the following statement: "Solar faculæ consist of solid or liquid bodies of a greater or less magnitude, either slowly sinking, or suspended in æquilibrio in a gaseous medium." The writers give elaborate tables digesting the Kew observations on the relative position of faculæ and spots, and they say that out of 1137 cases, 584 have their faculæ either entirely or mostly on the left, while 508 have it nearly equal on both sides, and only 45 mostly on the right." From this they conclude that the faculæ have been uplifted from the very area occupied by a spot, and have fallen behind to the left, from being thrown up into a region of greater velocity of rotation. They likewise give reasons for supposing that "a spot including both umbra and penumbra is a phenomenon which takes place beneath the level of the sun's photosphere."

Another important question relates to the probable comparative temperature of the darkest or lowest part of a spot. The writers accept its lower luminosity as an indication of less heat, and they conceive that a downward rush of a cold atmosphere surrounding the photosphere gives rise to the appearances that are observed. They say, "in conclusion we would venture to suggest that if the photosphere of the sun be the plane of condensation of gaseous matter, this plane may be found to be subject to periodical elevations and depressions in the solar atmosphere. It may be that at the epoch of minimum spot-frequency this plane is uplifted very high in the solar atmosphere, so that there is very little cold absorbing atmosphere above it, and therefore great difficulty in forming a spot. If this were the case, we might expect a *less* atmospheric effect, or gradation of luminosity from the centre to the circumference at the epoch of minimum than at that of maximum spot-frequency. Perhaps on some future occasion we may be able to produce evidence of this, and even of the unequal atmospheric effect of the two limbs of the sun at the same time; but in the mean time we shall content ourselves with suggesting this to the observers of our luminary as a simple inquiry that may possibly prove productive."

The scientific world is deeply indebted to Messrs. De La Rue, Stewart, and Loewy for many valuable remarks which the

first part of *Solar Physics* contains, and whatever theories may ultimately prevail, they must to a great extent be based upon, and take due account of the very large mass of carefully-assorted facts which the tables they have published present for consideration.

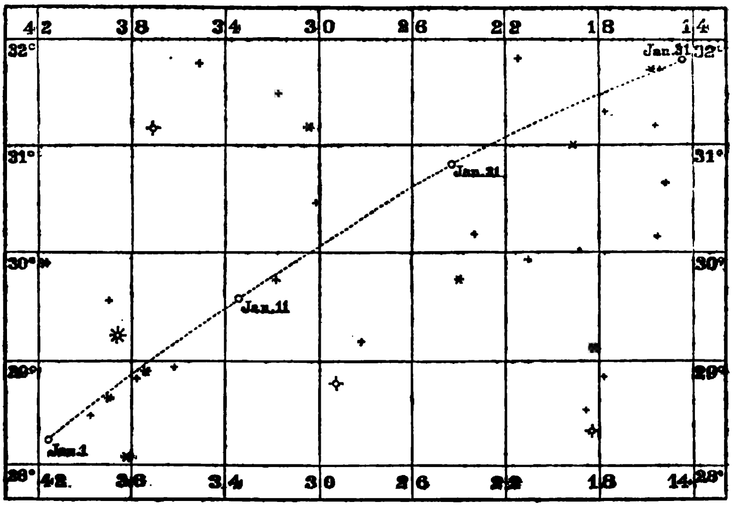
OPPOSITION OF CERES.—OCCULTATION.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

Few, probably, of our readers have seen the chief of the Minor Planets, Ceres; not so much from deficiency of brightness, at least when in a favourable part of its orbit, as from not knowing where to find it, or not having their attention directed to it. The opposition of this remarkable member of our system is now closely approaching, being calculated for January 21; and we are therefore desirous, for reasons which will soon appear, that such an opportunity for observation should not pass by unnoticed. Fortunately the planet will be situated at a considerable altitude, and in a portion of the heavens where identification will not give much trouble, as there will be a good *pointer* for the occasion, *ι Cancri*, a beautiful double star, No. 6 of our list, easily recognized by means of the instructions given in Intellectual Observer, vol. i. page 277, and the accompanying diagram, for which we are indebted to the kindness of Mr. Knott, will render it a matter of little difficulty to find the planet.

The figures at the top and bottom, it must be observed, denote minutes of R.A. in the 8th hour, those at the sides express N.D. The dotted line is the path of Ceres for the month; the large star beneath which it will pass during the first week is *ι Cancri*. This is 4·2 mag. of Argelander's scale; the others descend as far as 8·4; the planet itself ranging from 7·4 to 7·3 (or a somewhat higher rate according to Sm.'s scale). Though not visible to the naked eye, it will be readily seen, even with very small telescopes, and may be easily followed from night to night. It will, however, of course require a certain amount of aperture to detect the soft, steady character of reflected light, which will distinguish it from the flashing and sparkling aspect of the neighbouring stars; and a still greater degree of light and power will be demanded to exhibit its planetary disc, and to bring out the nebulous atmosphere by which it has been said to be surrounded, and the verification of which, if it exists, is an object of so much interest. As to the

disc, though very diminutive, and, as it seems, less sharply defined than that of the other planets, there can be no doubt of its visibility. This, as well as its reddish tinge, was established soon after its first discovery by the concurrent testimony of ♅ and Schröter, and it may be perceived with smaller instruments. Smyth tells us that with the 5·9-inch aperture of his achromatic he could easily "raise" it, that is, draw it out by increase of magnifying, from the point-like appearance which, with a low power, would resemble that of a star. The nebulous envelope may be more questionable. ♅ may be said to incline to its existence rather than to assert it with confidence. Thus, 1802, February 7, using a 10-ft. Newtonian reflector, aperture 8·9 inches, and power 516½, he finds "an ill-defined planetary disc, hardly to be distinguished from the surrounding haziness."



April 21, when he viewed it for nearly an hour, "there was a haziness about it resembling a faint coma, which was, however, easily to be distinguished from the body." April 22, "I see the disc of Ceres better defined and smaller than I did last night. There does not seem to be any coma." April 28, "Ceres is surrounded with a strong haziness; . . . the breadth of the coma beyond the disc may amount to the extent of a diameter of the disc, which is not very sharply defined. . . . The coma is very dense near the nucleus, but loses itself pretty abruptly on the outside, though a gradual diminution is still very perceptible." April 30, "Ceres has a visible but very small coma about it. This cannot be seen with low powers, as the whole of it together is not large enough, unless much mag-

nified, to make up a visible quantity." May 1, "The diameter of the coma of Ceres is about five times as large as the disc." 20-ft. reflector, power 477, the coma considerable. May 2, "Ceres is better defined than I have generally seen it. Its disc is strongly marked, and when I see it best, the haziness about it hardly exceeds that of the stars of an equal size." May 4, 10-ft. reflector, "I compared Ceres with two fixed stars, which in the finder appeared to be of very nearly the same magnitude with the asteroid, and found that its coma exceeds their aberration but in a very small degree. . . . 20-ft. reflector, found that the coma . . did not much exceed that of the stars. I also found that even the fixed stars differ considerably in this respect among themselves. The smaller they are, the larger in proportion will the attendant haziness show itself. A star that is scarcely perceptible becomes a small nebulosity." In drawing, however, his final result, he admits the existence of a visible nebulous atmosphere.

Schröter is more positive upon the subject, and his little book, published in 1805, and entitled *Lilienthalische Beobachtungen,* contains a good deal of curious information with respect to the three minor planets known up to that date, Ceres, Pallas, and Juno. The former, having been discovered by Piazzi at Palermo on the first night of the present century (a memorable epoch in our knowledge of the solar system), and subsequently of course lost sight of in its approach to the sun, was once more detected, in consequence of Gauss's calculations, by Olbers at Bremen, exactly twelve months after the date of its discovery, and on January 6, 1802, it was seen at Schröter's observatory, at Lilienthal, near Hamburg, by his assistant Harding, with an excellent 13-ft. Newtonian reflector of 9·5 inches aperture, powers 136 and 288,* as a faint nebulous object, about 2″·5 in diameter. January 25, Schröter saw the disc as sharply defined as that of Uranus, encompassed by a very narrow mist, and measuring, with the latter, 2″·514. January 26, it had a more nebulous outline, though in a clearer air, measuring 2″·687. January 28, much the same, well but not sharply defined, 2″·795. January 31, very ill defined, no distinct disc, though in a very clear sky, 2″·930. He now began to be struck with the regular increase in the measures. February 5, better defined than usual, and planetary-looking, though not as distinct as on January 25; measuring very satisfactorily 3″·463. February 10, the air was fine, but its

* This instrument, made by Schräder, of Kiel, in 1792, appears to have been of very superior quality; at the distance of 140 paces, the smallest print could be read with a power of 1500. Schröter employed it extensively in his lunar researches. It has been carefully preserved, and was advertised for sale two or three years ago.

aspect was very nebulous, without a distinct disc, notwithstanding the presence of bright moonlight, which, as he remarks, increases the sharpness of planetary definition, and accordingly permitted Uranus to be seen with beautiful precision. The measures gave 3″·548 for Ceres; for Uranus, which till measured had appeared evidently the larger, 3″·475. On this occasion, the remote planet's disc appeared to exceed that of the nearer one in sharpness as much as the latter surpassed that of the planetary nebula near *ν Aquarii* [I H_8. iv.]. February 12, bad definition, 3″·621. At this time our observers received a letter from Olbers, stating that on the 10th he had estimated the disc of Uranus at least twice as large as that of Ceres; which, in fact, might have been expected from the limited aperture of his achromatic, only 3¾ inches. A comparison of the regular increase of measures with the diminished distances of the planet from the earth (the rate of which had not been known at the time of measurement) proved that, assuming the disc to have been 2″·527 on Jan. 26, it would have amounted to only 2″·754 on Feb. 12, and hence Schröter concluded that the greater proportional increase must have been due to the increasing visibility of the exterior strata of the atmosphere during the planet's approach to the earth; as had been, he considered, the case with the comet of 1799. Feb. 18, notwithstanding a full moon, the measure amounted to 3″·048, with a cometary aspect. Mar. 5, clear evening, but no disc perceptible. Mar. 6, more distinct, and though very cometary, measuring 3″·843, whence he inferred a variable state of its own atmosphere. Uranus appeared at the same time perfectly defined, and like a miniature Jupiter without the polar flattening. Mar. 7, bad definition; 3″·965. Mar. 8, 3″·994, the brighter centre reduced by passing clouds to a much more defined disc of 3″·037. Mar. 14, disc more defined in strong moonlight, 3″·979, or in sharper glimpses, 3″·342. His most excellent 10-ft. achromatic, by P. Dollond, of $3\frac{8}{10}$ inches aperture, never showed any measurable disc or distinct coma; just as it was unable to reach, in the great nebula of Orion, many details of faint luminosity which the 13-ft. reflector showed with perfect distinctness. Opposition, Mar. 16. Mar. 20, disc more defined than recently, and brighter; somewhat exceeding even Uranus: 4″·105, and for the densest portion 3″·263. Mar. 28, 4″·021, and through flying clouds 2″·915; keeping the same proportion as before.

Here is certainly a strong case, both as regards positive nebulosity and actual magnitude, and one which would have appeared still stronger in the latter respect, if we had recounted all the precautions taken by Schröter and Harding to ensure

correct results, as well as the instances of high accuracy previously attained in the use of the same instrument—the projection-micrometer. This very simple apparatus, consisting only of a number of suitably illuminated discs, differing in size and variable in distance, among which the telescopic image is projected by the simultaneous use of both eyes, seems worthy of more attention than it has received, especially at the hands of the possessors of Newtonian reflectors, for which it is best adapted. It has much advantage in the convenience of illumination, and still more in not being sensibly affected by slight inaccuracies of workmanship or adjustment; but it requires, probably, a good deal of practice to secure ultimate correctness. But while Schröter and Harding had good reason to be satisfied with their own proceedings, a strange discrepancy in the observations on this side the water must have proved not a little annoying to them, as it certainly was startling to the astronomical world. After a very fair agreement in this respect for twenty years between the observatories of Slough and Lilienthal, Sir W. Herschel, employing the same mode of measurement, had been deducing results of marvellous contrariety with regard to the two new planets, or, as he preferred to call them, asteroids, Ceres and Pallas; allowing to the former a diameter of only 0″·351 at its mean distance, equal to about $\frac{1}{10}$ of the measure obtained at Lilienthal! "Certainly," as Schr. remarks, "never has a contrast altogether so extraordinary existed, since practical astronomy has admitted of accurate and minute measurements." The Hanoverian observer set himself, therefore, with all diligence, to examine the possible cause, and satisfied himself of the correctness of his own results by arguments which, as usual, he has worked out with painstaking copiousness of detail, but of which we can only give an outline. He remarks —and, it must be owned, with apparent justice—that a disc of such minute dimensions, shining with reflected and hazy light, could not by any possibility have been circumstantially studied by each observer with the greatest agreement as to physical aspect: that his own repeated comparisons with Uranus confirm the apparent size he assigned to Ceres: that Harding saw it as large again as the 1st satellite of Jupiter, instead of six times smaller, according to H's measure: and that on such a supposition it must have been perfectly imperceptible in the finder at Lilienthal, which, on the other hand, showed it twice as large as that satellite. An error, therefore, he believes, must have crept into H's measurements, and he proceeds to trace it. He points out the incorrectness of drawing conclusions from only the smallest (not from a mean) of three such very discordant values, 0″·40, 0″·38, and 0″·22, and found by

actual experiment that measures by the projection-micrometer could not be depended upon beyond the distance at which a good sight can read ordinary writing, such as from five to seven feet, or somewhat more: within these limits, measures at the utmost will not differ more than $\frac{1}{14}$; but at great distances, to say nothing of the attendant inconveniences, the comparison-discs appear, from irradiation, of an entirely deceptive magnitude. On looking at such a disc, placed at a distance of 178 feet, with both eyes, the left free, the right directed through a small sextant-tube without lenses, he found the image in the left eye five times larger than in the right: and the reversal of the appearance, on changing the tube to the other eye, proved the certainty of the illusion, which diminished with the distance, but did not disappear till the disc was only eight feet from the eye. And hence, as ♅ had compared Ceres with a disc at nearly 162 feet, the extraordinary discrepancy was accounted for; a conclusion which was confirmed by the circumstance, that the deviation in ♅'s measure of Pallas, with a disc placed as far as 178 feet, had been even greater than in the case of Ceres. The first suspicion of this cause of error, he says, in the recollection of his own innumerable measurements with the projection-micrometer, "made a frightful impression upon my whole soul;" from which, however, he was entirely relieved by finding that the dissimilarity wholly vanished considerably beyond the limits of such distances as he had invariably employed for twenty years. ♅ himself had, in measuring Uranus, discovered that equal comparison-discs at equal distances from the eye would appear of unequal size if unequally illuminated; and that his disc-micrometer gave the measure $\frac{1}{6}$ too small from irradiation: as indeed must naturally have resulted from his distances of 49 and 57 feet. And Schr. fully confirmed his own view, by measuring subsequently the little planet Juno with a disc at $143\frac{1}{3}$ feet; the result being $0''\cdot50$ instead of $2''\cdot526$ as given at a due distance. In addition to all this, he also urges the unsuitableness of employing magnifying powers so high as to lose the rarer parts of the nebulosity, and reduce the visible object to merely its brighter centre: and he remarks, that had the diameter of Ceres been so extremely small, its planetary light never would have been distinctly seen, as it was on Dec. 19, 1804, at a much greater distance from the earth (2·673 instead of 1·9 to 1·6), with an achromatic of scarcely two inches aperture, magnifying 21 times; nor would it, he maintains, in the 13-ft. reflector, have preserved its disc of about $1''\cdot5$ through a green glass which greatly reduced the magnitude of a brighter star; nor could it have been so much more conspicuous than Titan, to which his measures gave

a diameter of 0″·7. He therefore considers himself justified in ascribing to Ceres a diameter of about 1620 English miles, instead of the 163 of ♅; to which he would add a height of 675 miles for an atmosphere of varying density and aspect, as far as it could be traced with his 13-ft. reflector.

Such are the arguments of Schröter, in a very condensed form; and with all possible respect to the memory of one who must ever be honoured among the greatest astronomers, it must be admitted that they have a force which it is not easy to evade. It is not indeed unlikely that he may have erred in excess; but still his approximation to truth is probably much closer than that of his great rival. No subsequent measurement of Ceres seems to be recorded,* nor does it appear upon what grounds Humboldt has asserted that "the cometary clouds, in which the small planets were at first supposed to be enveloped, have disappeared on investigation with more perfect instruments." It ought, however, to be mentioned that Lamont's result with the sister planetoid Pallas, obtained with a great (11 or 12 inch?) achromatic at Munich, giving it 670 miles in diameter, instead of the 75 miles of ♅, tends strongly to confirm the view of Schröter.

We have ventured to give a large amount of detail in this instance, from an impression that this curious discussion is but little known, at least in England, and from a conviction that, with the far greater optical advantages of the present day, the true dimensions of this remarkable body, and the existence and extent of its atmosphere, might be, and ought to be, more correctly ascertained.

OCCULTATION.

Jan. 30, *a* Cancri, 4 mag., 8h. 39m. to 9h. 45m. (very nearly at the time of Full Moon).

* Prof. Stampfer of Vienna is stated to have given measurements of 39 of the Minor Planets by means of photometry, among which Ceres stands at 227 [German or English?] miles. The mode of procedure, however, can hardly lead to any satisfactory result; especially as in this instance it must involve the precarious assumption of equality of reflective power and atmospheric transparency in the objects of examination.

PLEASANT WAYS IN SCIENCE.

No. III.—Identity and Change.

To be the same, and yet different, is one of the curious problems which science presents to us. It appeals to us when we encounter the question of personal identity, and are certain that the old man passing away from us down the vale of time is the same individual that, eighty years ago, commenced his visible being under the care of nurses, who supplied the wants of infancy, enabled him to grow to childhood, to youth, to manhood, to maturity, and then to old age. All through life identity and change are exhibited to us. Each breath takes away a portion of the being that was, and brings into our organization a portion of the being that is to become; and yet we feel there is a larger and broader identity of individuality preserved throughout all these changes than can be accounted for upon any principle of discarding physical organization from our reckoning, and looking only to the spiritual essence that has pervaded and animated each stage. Whatever may be the nature or the mode of connection of mind and spirit, they seem so bound together, that all the gradations of our being may be compendiously spoken of as parts of the one enduring I.

Psychologically, the I may be conceived to begin with its own consciousness, and to endure so long as that consciousness remains. If, indeed, as some have supposed, consciousness went to sleep for ages, and then revived, only a prolonged slumber would have affected the I, and that slumber of ages might seem to it only like a momentary interruption of those processes of thought, feeling, and sensation by which we know that we exist.

We cannot look upon our physical organization as nothing more than a machine which our mind or soul plays upon like an instrument, or receives messages from like a king. It may perish while we remain. It does so perish day by day, and we do remain. The new materials take the place of old ones, but those materials which help to compose us at any moment seem to constitute a veritable and, for their time of office, an essential portion of ourselves.

Passing from conscious identity in the midst of change, let us take a survey of the lowest class of change and identity that we can conceive; and we find it beautifully illustrated in a dialogue in Oersted's *Soul in Nature.* The scene is a waterfall, and the Swedish philosopher makes one of his speakers exclaim, "You here receive an impression of the fall

of a great mass of water, which every time comes from the same enormous height, and always encounters the same obstacles. The dispersion of the drops, the foam, the sound occasioned by the fall, as well as by the roaring and foaming of the water, which always arise from the same causes, ever remain the same. In the impression which all these things produce upon us we feel a variety, but at the same time a totality; or, in other words, we feel the variety of the single impressions as the effect of one great action of nature produced by the peculiar conditions of the locality. Perhaps the invariable in this phenomenon might be termed the thought of Nature inherent in it."*

It is the peculiar function of organic nature to exhibit a higher kind of identity amid change, and the quantity of regulated and co-ordinated motion that takes place in an organism is a measure of its perfection and importance. The animal stands higher than the tree, and its various processes of growth and action are dependent upon or associated with the putting together and the taking to pieces of more complicated substances than those which constitute the great bulk of the plant. The muscular system of animals exhibits a complexity of chemical formation corresponding with its elaborate arrangement of parts. The nervous system of animals is remarkable for its chemical complexity; and no thought, feeling, or volition occurs in a living body, without a multitude of atoms undergoing oscillation and changes of place.

If we consider our globe as an individual orb, we trace again the co-existence of identity and change. In one sense, it is certainly the same globe as that on which the Mastodon trod with monster step—the same as that across the fields and lakes of which the Pterodactyl, or great flying lizard, stretched his dragon-wing—the same as that over whose morasses gigantic ferns waved their branches at one period—and in whose seas, in a remoter age, the so-called Eozoon built his complicated house. Nay, we may go further back, and accepting as probable the nebular hypothesis, we find it the same globe as that molten ball which resulted from the condensation of those thin and subtle gases that were the physical progenitors of all the structures it now contains. Whatever name it bore amongst the immortals, by that same name, bearing testimony to its identity, it may be known through all the ages of future and of ceaseless change. Its destiny may be to pass through modes of existence as different

* We quote this passage from Bohn's edition of the translation made by Leonora and Joanna Horner. We have omitted the word "*superficially*," which in the translation precedes "termed," as it can scarcely, in its ordinary acceptation, express Oersted's meaning.

from that in which we now find it, as its present form and aspect differ from the nebulous cloud, or the seething fiery ball, and it will still be what man in his day denominated the earth —but yet how changed!

Mental identity is evidenced by continued and recurring consciousness. Could we conceive a being that only thought and felt once in a thousand years, he might be as certain of his existence and of his identity as another being capable of evolving thought and becoming conscious of feeling any number of thousand times in a second. We have clocks with short pendulums, and clocks with long ones; and could we construct a chronometer with a pendulum so long, that it would require ages for the completion of its gigantic sweep, its far-separated beats would bear the same relation to each other, and testify to the identity of the instrument, as completely as does the quick and busy ticking of the little watch.

We cannot limit the time distance between the co-ordinated successions that may be comprehended under one identity, nor can we limit the space distance of portions of one great whole. In the fabric of a little ball which we can hold between our fingers incessant motions are going on, but yet the ball remains the same for its appointed time. All its particles, with all their movements, are, so to speak, under the dominion of, and are the expressions of, the same idea. The globe, with its mightier changes, has a similar identity; the solar system is *one* again in its harmonious relations—ever changing, but yet the same. May we not go further, and see a still more gigantic oneness in the entire universe, imaging the greatest oneness which man is able to conceive?

It is common, though scarcely philosophical, to speak as if each globe and system constituted an isolated existence. Modern philosophers have indeed imagined—without sufficient reason—that the sun continually receives additions to his mass in the shape of bombarding meteors, whose crash against his sides they suppose the physical cause of the renewal of his heat; and comets, in their eccentric orbits, have been thought likely to roam within the attraction of bodies powerful enough to stop their wanderings and appropriate their materials. But there is a wider supposition that seems to have the reasoning of analogy to commend it, and according to which all the matter throughout the universe is in eternal flux. Here nebulæ condense into planets, or suns; there suns and planets dissipate into nebulæ. Astronomers and physicists fill space with an ether, whose vibrations are light and heat; but if such an atmosphere of space exists, why should it be subject to vibrations only? Why should not, as some have supposed, this all-enwrapping ether-sea have its currents and its waves?

Why should not its very material be condensed in this place, and renewed or re-etherized in that? To be anything which concerns *physical* science, this ether must be a form of matter; and if so, why should not we consider it as an atmosphere common to all worlds, and possessing properties, in reference to all the host of heaven, bearing some analogy to the properties which an individual atmosphere bears to an individual globe?

In a former number of the INTELLECTUAL OBSERVER, an instrument, the "Rigid Spectroscope," an invention of Mr. Browning, was described as devised for the performance of some experiments suggested by Mr. Balfour Stewart. That able physicist wished to see whether, by moving a spectroscope from a low latitude to a high one, and thus materially changing the force of gravity, any motion, however slight, would be made in the position of certain spectrum lines. In point of fact, he wished to try whether light could be weighed. We believe the Admiralty will assist in the investigation, and that before long a ship will carry the instrument to some appropriate place. There are only two probable suppositions with respect to light, heat, and other so-called "imponderables," either that the ether whose vibrations they are supposed to be, could be weighed if apparatus of sufficient delicacy were contrived, or that gravitation is not an essential quality pertaining to matter under *all* conditions; but uniformly making its appearance under *certain* conditions. The inquiry is full of interest, and when conducted to a successful issue, will open the way to some of the widest and grandest of investigations that science has reached.

Chemistry opens before us very curious questions of identity and sameness. It shows us instances of the same substances having widely different properties in different conditions. The chemist recognizes two singular classes of bodies, the one he terms *isomeric* and the other *allotropic*. The isomeric consists of substances differing widely in appearance and properties, and yet composed of the same proportions, of the same materials. In some of these bodies the quantities of the elements are the same in actual weight, in others the proportion is kept, but the quantities may be twice as great, or even thirty times as great. The separate bodies of an isomeric series receive separate names, but allotropic bodies of the same pair or series have only one name, being considered as the same thing in two or more different states. Phosphorus is known in several states. Professor Miller says, "Phosphorus assumes several different forms under the influence of causes apparently trifling. The transparent variety when kept exposed to light under water assumes a second form, which is white and

opaque, and somewhat less fusible.* It has a specific gravity of 1·515, while phosphorus becomes reconverted into the vitreous variety by a temperature not exceeding 122°. A third form is obtained by suddenly casting melted phosphorus; it is perfectly black and opaque; while a fourth, or viscous modification, analogous to viscous sulphur, may be obtained by heating very pure phosphorus to near its boiling point, and suddenly cooling it. A fifth form occurs in the shape of red scales, which are obtained by the spontaneous sublimation of phosphorus in the Torricellian vacuum† when exposed to the rays of the sun."

This red phosphorus may be obtained by other means, and has been extensively used in the manufacture of lucifer matches, a most unhealthy business when common phosphorus is employed. It is not soluble in some liquids, like bisulphide of carbon, which dissolves common phosphorus. Instead of catching fire in the open air, as common phosphorus does at a comparatively low temperature, it must be heated to 300° before such action takes place, and instead of acting like common phosphorus as a powerful irritant poison, it may be swallowed with impunity.

It is impossible to place limits to the variety of substances that may be produced by different modes of arranging the same quantities of the same elements in various patterns. We recognize boundless diversity, but when does the identity stop? Is there only one ultimate substance capable of existing in different states? It is obvious that speculations concerning identity and change have a wide field in the regions over which chemistry presides. We have merely indicated some of the simplest, and with these for the present must be content.

The astonishing changes which animals undergo from the egg to their complete form illustrate other phases of the same theme. All creatures that we know of originate in a bud or an egg. Probably the egg always appears at some part of the series, and it is now certain that the most developed creatures, the mammalia, thus commence their being. Thus man and the silkworm both spring from eggs. In the higher forms of animals the hatching process precedes birth, in the lower the egg is born into the world, and changes take place within it which eventuate in the appearance of the infant stage of the creature that is hatched.

Natural history abounds in remarkable illustrations of the

* M. Baudrimont affirms that white phosphorus is not an allotropic form of common phosphorus, and that it only varies from the latter by having its surface corroded through partial combustion. If this be so, the general argument is not affected. M. Baudrimont's paper is in *Comptes Rendus*, 13th Nov., 1865.

† The upper and empty part of a barometer tube is a Torricellian vacuum. The air can only press up into the tube a column of mercury equal to its own weight. The tube is filled in the first instance, and tho mercury falls till the air column is balanced.

diversity of appearance presented by the same animal at different stages of its existence. In the insect world we know the caterpillar, the chrysalis, and the butterfly. The young Cyclops, a well-known water flea, common in all ponds, and with which our microscopic readers must be well acquainted, differs greatly from the adult form in the shape of the body, the absence of the long tail, the want of antennæ, and many other particulars. Still more remarkable are the differences between the young crab, in shape like a helmet with a tail to it, and the adult individual, and between the young star-fish, beginning life like a painter's easel, and the full-grown form.

What constitutes the individual identity of creatures that have no continuous consciousness, or no consciousness at all, and which in their separate stages differ as much as if each stage constituted the existence of a distinct being? At one time it was thought by some philosophers that all the organs and apparatus developed in subsequent life-stages existed in the first stage in a rudimentary form. This notion is untenable. The egg-stage of animals, widely differing from each other, may be indistinguishable, and yet in each egg some special arrangement of forces and materials exists which determines the kind of development that shall ensue; and in animals that pass through many changes of form and aspect, the form that precedes is, in effect, the parent of that which is to follow.

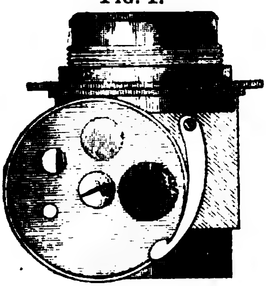
Are we to regard the seed and the plant as belonging to one individual identity. We cannot do otherwise; and in this case we have to note that from the seed the infant plant really grows, and the adult plant grows from the infant germ. The entire plant, at any one time, is continuous in its structure. But there are differences between buds and eggs, and must we take all the beings that arise from animal or vegetable buds of the same individual as partaking of its individuality? A bud may be, for example, a portion of an individual plant, and may be developed into a similar plant—aphides or plant-lice produce numerous offspring by buds as well as others at certain periods by eggs. Such cases are rather multiplications of the individual, than the production of fresh individuals.

We are accustomed to regard an animal as something complete in itself; but what shall we say when an organ of reproduction moves about as a separate thing from the creature of which it is a dissociated part? Natural history presents these curious problems. Facts of this kind have appeared, and more will appear from time to time, in our pages. They suggest profound and interesting thoughts. In this paper we have only approached the threshold of great questions. We have skimmed over a wide surface, hoping rather to stimulate inquiry in many directions than endeavouring to satisfy it in any one.

OPAQUE ILLUMINATORS FOR HIGH POWERS.

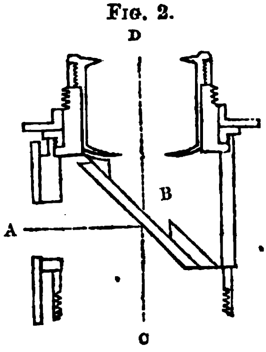
In the September number of *Silliman's Journal*, Mr. H. L. Smith, of Kenyon College, U.S., described a new illuminator he had contrived for the examination of objects under high powers by reflected light. His plan is to throw light through a lateral aperture on to a small silver reflector, so situated as to reflect the rays down through the object-glass on to the object. An instrument of this sort was recently sent by Mr. Smith to Mr. Lobb, accompanied by a request that he would invite Messrs. Powell and Lealand to make and introduce it to the English public. Those gentlemen did not read the description in *Silliman's Journal*, but, after experiment and consideration, modified Mr. Smith's plan in a way which they considered an improvement. The apparatus as made by them will be understood from the following diagrams. Fig. 1 represents its external appearance, and Fig. 2 gives a sectional view. The upper part of this apparatus screws into the body of the microscope like an adapter, and its lower part carries the object-glass. Light entering one of the round holes in the circular diaphragm strikes against a piece of glass B, which reflects a large portion of it downwards in the direction C, where the object-glass is placed. The object-glass condenses the light upon the object beneath it, and the return rays from the object pass up again through the object-glass, through the piece of glass at B, and on to the eye of the observer in the direction D.

Fig. 1.



The inclination of the piece of flat glass B is the most favourable for the reflection of the incident light down to C, and the rays on their return through the object-glass strike D at a different angle, which permits a much larger proportion to pass straight through, while another portion is reflected back again and lost.

Fig. 2.



Mr. Richard Beck, who, like Messrs. Powell and Lealand, had not seen *Silliman's Journal*, heard that Mr. Smith's plan was to throw the light down through the object-glass by means of a mirror that cut off a portion of its aperture, and he, without any concert with Messrs. Powell and Lealand, hit upon

an arrangement substantially the same as theirs. Instead of using a piece of glass with the two sides ground parallel, Mr. Beck mounted a disc of thin covering glass, so that it could be placed across the tube of his apparatus at an angle of 45°, or at such other angle as might for special purposes be desired. He did not introduce the diaphragm which Messrs. Powell and Lealand copied from Mr. Smith's pattern. Messrs. Powell and Lealand devised their plan a few days before Mr. Beck devised his, but the latter gentleman was the first to exhibit it *in public* at the last meeting of the Microscopical Society, previous to which Mr. Lobb had received their instrument from Messrs. Powell and Lealand. This rapidity in devising what to both of them was a novelty, is highly honourable to both firms; but on reference to Mr. Smith's not very clear description, it seems probable that he had tried the very same plan and rejected it as less desirable than his own. His words are, "I attempted at first to employ as the reflector a disc of the thin glass, or *two or three of them*, used as covers of microscopic objects." The words we have italicised may throw a doubt as to *how* he used the thin glass, as we cannot imagine he would put one behind the other in the same plane. He found this plan, however he carried it out, gave a field of "peculiar flatness," that is to say his objects were not in sufficient relief, and he states that on this account he preferred the unilateral illumination from a small silver mirror placed on one side, so as to occupy a position somewhat near the letter B in Fig. 2.

We have tried Messrs. Powell and Lealand's and Messrs. Smith and Beck's pattern, and both give *highly important*, and approximately good results. Neither the thin glass, nor the thicker glass with parallel sides, interfere as might be expected with the definition of high powers; on some accounts we prefer the thin glass; but it is easily broken when it requires wiping, and *very easily replaced*. The power to move the glass in Mr. Beck's plan we look upon as an advantage, and with regard to Powell and Lealand's we find their diaphragm decidedly useful.

Those who wish to study the effects of vertical illumination, as compared with oblique illumination, should experiment with the admirable reflector made by Mr. Beck for Mr. Sorby. When oblique light is wanted for powers of one and a half or one inch, or two-thirds, this is by far the finest illuminator we have tried, and in a moment a plane mirror can be put in such a position as to substitute vertical illumination for oblique. The effect is marvellous with many objects. *Penetration* is instantly lost, and every minute surface marking wonderfully shown. Thus special information of a very valuable kind is gained. When vertical illumination is applied to high powers, their penetration is much lessened, but

not lost to the *same extent* as with lower power. They have, in fact, nothing like so much to lose. The difference is in other respects the same.

The two forms of illuminator for high powers which we have described, will work, as we have found, with a fifth and with a 1-20th upon any object sufficiently flat, and possessing sufficient reflecting power. Very minute markings can be seen; but it is far from easy, if possible, to avoid the appearance of a certain milkiness in the field. Possibly—but we cannot yet say—the plan adopted by Mr. Smith may be the best, but the three plans will stand in successive positions of complexity and price. Mr. Beck's is the simplest and cheapest. Messrs. Powell and Lealand's is in some respects more complete and more costly, and when these latter gentlemen produce, as they intend doing, a more close imitation of Mr. Smith's, its complexity will be greater and its price must be proportionately higher. The subject is too new for us to be able to say more than that these reflectors are highly important inventions, which deserve the immediate attention of all careful microscopists.

PROGRESS OF INVENTION.

Improvement in the Process for Obtaining Carbonate of Soda.—The economic production of carbonate of soda is of considerable importance to several of the arts and manufactures. The process invented by Leblane for the purpose was so effective and convenient, that it has remained in use with scarcely any modifications for a long period. It consists in heating common salt with sulphuric acid; forming, by means of caustic lime, and carbonaceous matters, a mixture of caustic soda and its carbonate, from the sulphate which is obtained; dissolving these in water, to separate them from the other substances with which they are associated; evaporating the solution, and changing the caustic soda of the residual mass into a carbonate, by heating to a high temperature with sawdust; then dissolving out the salt, concentrating the solution, and crystallizing. This process has now been simplified, by decomposing the sulphate of soda obtained from common salt with caustic baryta, which throws down insoluble sulphate of barytes; and then changing the caustic soda which remains in solution into carbonate, in the ordinary way. It is probable that this method would have come into use long since, had it not been found troublesome and expensive to separate the sulphuric acid from sulphate of barytes, so as to obtain economically the required caustic barytes. Mr. Hunter has, however, overcome these difficulties, by acting on the sulphate of barytes with lime, under a pressure much more considerable than

that of the atmosphere, which he found imparted to the lime the required decomposing power.

Vision under Water.—It is easy to distinguish objects at moderate distances under water, provided the eye does not come in contact with the fluid; if it does, nothing more than a uniform mass of light is perceptible. This is very easily explained: the anterior surface of the eye forms a plano-convex lens with the water in front of it, which possesses such a dispersive effect as prevents the eye from any longer having the power of bringing the pencils of light to a focus, and forming a picture on the retina. The remedy, though apparently obvious enough, did not suggest itself until recently; it consists in counteracting the effect of the aqueous lens by means of a convex glass lens. It is clear that various forms of lens might be used for the purpose; the fact being borne in mind that, on account of the convexity of the eyeball, the concave surface of the aqueous lens has a radius of curvature scarcely greater than 0·31 of an inch. It is found, however, by calculation, that a double convex lens of flint glass, the surfaces of which have a radius of 0·48, answers the purpose; not making allowance for the peculiar kind of glass, or the adjustment required to suit the vision of different persons. A suitable lens renders objects under water distinctly visible: and it is therefore of great importance to pearl divers, collectors of sponges, and others who are obliged to operate under water, with the fluid in contact with their eyes; but it is to be observed that when it is used, the eye no longer possesses the power of adjusting itself to different distances: and hence objects cannot be seen with it at a greater distance than about three yards.

Economic Extraction of Vegetable Oils.—The oils found in various seeds, etc., have been hitherto obtained usually by means of pressure; but this is both a troublesome and a wasteful method. It has been found that any of the hydro-carbons obtained from petroleum or other mineral oils, or from asphalte, coal, slate, etc., and which boil at a temperature lower than 100° C., afford a means of extraction which is far better in every respect. The seeds, after having been bruised, are placed in a vessel which is capable of being closed hermetically, and the hydro-carbons are then introduced into the vessel. The oils are dissolved; and the solution having been run off, the hydro-carbons are removed by distillation, which is effected by means of steam that is made to pass through them, by means of a helical tube in the interior of the vessel in which the distillation is effected. Before the seeds and the hydro-carbons are brought into contact, they are slightly warmed; and the same seeds are to be acted on successively, with two or more different portions of the solvent, that the whole of the oil may be extracted.

Permanently Plastic Modelling Clay.—The rapidity with which ordinary modelling clay dries, is a source of great inconvenience to sculptors, etc.; but the difficulty arising from this circumstance may be obviated by very simple means. The fact that glycerine has no tendency to dry in atmospheric air has been already used with advantage. Its latest application consists in its employment as a means of

moistening modelling clay. The product thus obtained will possess all the good qualities of wax, but will be considerably less expensive; and it will be superior to it, in remaining of the same consistence at all temperatures. Before the glycerine is added to the clay, the latter must be well dried and pulverized. Any water left in it would subsequently destroy the plasticity; as it would pass off by evaporation, and thus leave the clay without sufficient fluid to secure to it a proper consistence.

New Mode of Producing Light for Photographic Purposes.—The discovery of the excellence of magnesium as a means of producing light has been of great advantage to the photographer; but its utility is still greatly limited by its cost, notwithstanding the improvements that have been made in the mode of obtaining it. A source of light which is very much less expensive, and which is extremely convenient, when a large mass, such as a landscape, is to be taken at night—which would require the consumption of large quantities of magnesium—has recently been discovered by M. Sayers. Twenty-four parts by weight of nitrate of potash, seven parts flowers of sulphur, and six parts red sulphuret of arsenic are thoroughly mixed. This composition, when set on fire, affords a most brilliant light; and the negatives it produces give most excellent positives. The contrast between the lights and shades, which with artificial light is liable to be very great, may be easily softened down, by igniting at once two portions of the mixture; one the more powerful, to light up the subject, and the other to modify the tones; an agreeable effect will thus be secured. It has been found that about half a pound of the mixture will afford light for half a minute—a space of time abundantly sufficient for ordinary purposes.

Further Utilization of the Aniline Dyes.—The beautiful colours derived from aniline have already received a very general application; but they have been, hitherto, unsuitable to one purpose which, of all others, would be most likely to benefit by the brilliant effects they produce—oil painting. They are now, in consequence of a recent discovery, very likely to become extremely useful in this branch of art. It has been found that a solution of aniline is capable of dissolving caoutchouc, and all the resins which have acid properties, and also the aniline dye stuffs. The application of this important fact is obvious. For example, the solution of shellac in aniline may be coloured by the addition of the concentrated solution of aniline dye stuff; the result being a transparent paint, which answers admirably for glass, porcelain, etc. This shellac solution may be mixed with any oil paints that contain no lead; and thus an oil paint of extraordinary brilliancy may be obtained. With the exception of fuschine, which, if heated with shellac, is changed to blue, all the aniline dyes may be dissolved in the aniline solution of shellac itself. When, however, fuschine is to be used, it must be dissolved in aniline without heat, and its solution then be mixed with the shellac solution.

Origin of the Staffordshire Iron Ores.—The source whence the iron ores of the Staffordshire coal measures have been derived

admits no longer of doubt. They had the same origin as the bog ores which are still being formed in the Swedish lakes: and which consist of carbonate of the protoxide, formed from hydrated peroxide by the organic matters with which these lakes abound. This important fact has been established, by a fossil belonging to the genus *Unio* having been found among these ores, and exhibiting the same constituent as they, and also the important peculiarity of belonging to a genus of mollusca, all the species of which are found exclusively in fresh water. We may infer, therefore, without hesitation, that these ores are a fresh-water formation, due to causes which, to a limited extent, are still in operation.

MISCELLANEOUS.—*Applicability of the Electric Light to Lighthouses.*—The superiority of the electric light for the purpose of lighthouses has, for a considerable period, admitted of but little doubt; but the French Government seem to consider the question regarding it as now set at rest. For some time past, magneto-electric machines, with four discs, have been in use at the lighthouse of Cape de la Héve: producing a light in every way greatly superior to that obtained by the old method, and visible at the distance of twenty miles. They have now been replaced by others, having six discs; capable, when required, of giving a light equivalent to 10,000 cancel burners, or 100,000 candles, and visible at the distance of twenty-seven miles.——*Ozone.* Some important information regarding ozone has recently been obtained. The researches of M. Frêmy have led to the conclusion that our methods of detecting it in the atmosphere are not to be relied on. It is certain that the tests for ozone are similarly affected by a variety of substances, such as the oxygen compounds of azote, ammonia, formic acid, the products of combustion, and other bodies, many of which, including dust, are present in the atmosphere. He advocates the employment of silver as the reliable test; its surface being oxidized if moisture containing ozone is passed over it. Others also, and among them M. Berigny, have investigated this important subject. The researches of M. Soret have rendered it extremely probable that ozone is oxygen is an allotropic state, and having a density one and a half times that of normal oxygen. He found that when oxygen is ozonized, its volume is diminished; that when ozonized atmospheric air is acted on by iodide of potassium or other oxidizable bodies, the ozone is absorbed, but the volume is not changed; that, under the influence of heat, ozonized air so expands that the increase of volume just equals the amount of oxygen capable of uniting with iodide of potassium; and that either oil of turpentine or oil of cinnamon absorbs ozone without decomposing any of it—which is not the case with the other bodies that absorb it. He found that when ozonized oxygen is treated with oil of turpentine, the volume is diminished to an amount very nearly equal to twice that occupied by the gas absorbed by the iodide of potassium, and also to twice the increase of volume produced when the ozone is decomposed by heat.

ARCHÆOLOGIA.

CONSIDERABLE interest has just been excited in the West Riding of Yorkshire by excavations which mark either the site of the Roman town of CAMBODUNUM, or of some buildings connected with it. We have as yet, unfortunately, not very complete information on the subject, derived chiefly from the reports in local newspapers.

Cambodunum (there is no clear evidence that it is the same place which Bede calls Campodunum) appears to have been a town of importance under the Romans, and in the Itinerary of Antoninus it stands as the only place of consequence on the great road between Calcaria (*Tadcaster*) and Mamucium (apparently a mere error for Mancunium), or *Manchester*. Richard of Cirencester (a writer of at least dubious authenticity), in his Itinera, or, as it is called rather affectedly, Diaphragmata, appears to have made up this iter from Antoninus, and gives Cambodunum the same position; and in the previous part of his book he informs us it was one of the towns in Britain which enjoyed the Latian law, that is, that it was a town next in rank to a colonia. Though we have a difficulty in regarding the book which bears the name of Richard of Cirencester as anything else but a modern compilation, yet the compiler may have had some old fragments to work upon, and the rank he gives to the town of Campodunum is not at all improbable. Considerable difficulty in identifying the site of this town has arisen from evident errors in the numbers of the distances on this iter, as furnished by the manuscripts. The ignorant scribes of the Middle Ages, and no doubt many of those who preceded them, when copying manuscripts like those of the itineraries, consisting chiefly of numbers expressed in Roman numerals, leaving out an *x* or a *v*, or an *i*, or more than one, or interchanging one for the other, made so many errors, that we can never place any trust in them, and our safest evidence as to the site of a Roman town arises from finding traces on its line of road which answer to it. Such is the case with Cambodunum, which antiquaries have agreed generally in placing at Slack, in the parish of Huddersfield and township of Longwood, in Yorkshire, about four miles from Halifax. All the country round appears to be covered with traces of Roman settlements. Among the discoveries of this kind recorded, we learn that in 1743 the foundations of a Roman temple were found at Huddersfield, and, among other antiquities on the site, an altar dedicated to the goddess Fortuna, by a soldier of the sixth legion, named Antonius Modestus, which of course establishes a relationship with Eboracum, or York, which was the head quarters of this legion during the whole Roman period. In 1824, accidental discoveries were made at Slack, above mentioned, of considerable remains of Roman buildings, consisting of hypocausts, and foundations of walls. One of the tiles bore the inscription, stamped into it, COH·IIII·BRE. Camden states that this same inscription was found not uncommonly upon Roman bricks at Grimescar, near Huddersfield. It was assumed, rather hastily, by inconsiderate antiquaries, that it referred to a cohort of Britons, or even to a British

legion, which is quite inadmissible. Mr. Roach Smith, in his very valuable and already very rare volume, *Roman London*, page 116, has suggested that this inscription should be read, *Cohors quarta Breucorum*. The Breuci were a people of Pannonia, and we know that there were Pannonian auxiliaries in Britain; and then there were no doubt many people within the extent of the Roman Empire who sent bodies of auxiliary troops to Britain, of which we have at present no memorial. Since this last date there have been many discoveries of Roman antiquities over the district we are describing.

If any one of these discoveries represent the Roman Campodunum, it must of course be the one which lies upon the line of the Roman road, and on this point our information at present seems to be defective. The site on which the present excavations are being carried on is Slack, and the position, is one which might have been that of a Roman station, or of a Roman villa of importance. The present discoveries have resulted from the action of a local society, entitled the Huddersfield Archæological Association, which, under the direction of the Rev. George Lloyd, the incumbent of Thurstonland, has employed a number of men to excavate on the spot. These researches have brought to light a building sixty-eight feet in length, by sixty-four in breadth, the outer walls of which are of the usual Roman thickness of about three feet, a measure which was preserved by the mediæval builders in the walls of their houses within towns. Several internal walls were traced, inclosing a paved court. In the space between the inner paved court and the front wall of the building—we are quoting the printed description—a gold ring was found, described as "very much worn." In what appears to have been the central inner chamber, a silver coin of the Emperor Vespasian was turned up, and next day a coin of Nerva, both stated to be in a good state of preservation. Heaps of Roman pottery and bricks and tiles were collected, and among the latter some with the already well-known inscription, COH·IIII·BRE, or the fourth cohort of the Breuci, which seems to show that there was here, or in the neighbourhood, a military garrison, or, at least, a villa dependent upon one, and perhaps inhabited by its chief officer. Hypocausts were also found, and in them, among other relics, a fibula, a stone axe, and human bones. Here we have, of course, a stone implement belonging to the Roman period. In a corner of one of the hypocausts was found a large mass of metal, enveloped in wood, which at first was supposed to be silver, but, on examination, it proved to be the rich ore of lead known by the name of *galena*. It is stated that this mass weighs about 230 pounds. It would show some relationship to lead-mines or lead-works. By the side of it were found the remains of a human skeleton, and not far from it were those of a child. Whether these remains mark the site of the Roman Cambodunum, or merely those of a villa in its neighbourhood, they show that it was a military station of some importance, and that there were connected with it mining operations.

It is rather to be lamented that at a time when true and solid

archæological science has really made great advance, so many men should prefer starting theories founded upon nothing, and that so many others should throw away a great deal of ingenuity and energy upon shadowy speculations which might have been turned to good account. We have two examples before us. One is that of an inscribed OAK BEAM, or lintel, over a fire-place, in the manor keep at HEXHAM, in Northumberland. A Northumberland gentleman, with a great amount of cleverness, has made out the inscription to be Anglo-Saxon of the earlier half of the twelfth century, and gives an Anglo-Saxon reading of it, which would very much puzzle one of our Anglo-Saxon forefathers to make anything of; while any one acquainted with old English literature and manuscripts will recognize it at once as a good well-known hand of the *fifteenth* century. The inscription appears to consist chiefly of names of men. The other example to which we allude is the now rather celebrated NEWTON STONE, and its inscription. The late eminent Dr. Mill, led aside by Oriental prejudices, read it backwards and turned it into a Phœnician inscription, of an enormously early date, and revealing some most marvellous information. We see that a more recent writer, Dr. Moore, in a book upon the *Ancient Pillar Stones of Scotland*, has found out that it is in "*Arian* characters," and has given it an equally extraordinary interpretation. The stone belongs to a class of monuments well known to antiquaries, which range from perhaps as far back as the fourth or fifth centuries *after* Christ to the ninth or tenth. The original is a good deal defaced, but the first lines of it may easily be read, HIC IACIT (the usual form of the word at this period) CONSTANTINVS . . . . FILIVS . . . . The name of the father of Constantinus, and the remainder of the inscription are so much rubbed that it would require a little careful study to make it out, but we have no doubt that with this careful study it may be done.

The old acquaintance of all antiquaries, the *Gentleman's Magazine*, has just passed into new hands, and the first number of the new series will appear at the same moment with the present notice. We cannot but wish it well. The *Gentleman's* is the patriarch of English magazines. It was started so long ago as 1731, and continued as the most respectable member of the monthly periodical press for nearly a century, being then simply a journal of general literature and science. As such, it was associated with the names of Dr. Samuel Johnson and Goldsmith, and many other literary celebrities of the last century. It was, we believe, about or soon after, the year 1830, that a more especially antiquarian character was given to it, and when it passed from the house of Nichols to that of Parker, it received a stronger bias towards architectural antiquities, which of course made it rather more a class publication. The new proprietors, Messrs. Bradbury and Evans, purpose, as we understand, to restore it in some degree to its more ancient character of a general journal of literature and science. We can only say that we wish our old friend all success. We think, at the same time, that there is now a good opening for a journal, ably edited, and devoted especially to historical and antiquarian litera-

ture. Perhaps the new series of the *Gentleman's Magazine* will fill this void.

One of the BRONZE SWORDS, of which so much has been said of late, has been recently found near Rothbury, in the centre of Northumberland. It was buried in *debris* at the foot of a steep moorland hill, abounding in remains of roads, camps, etc., of apparently early date. T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*Nov.* 22.

SELENITE IMPRESSIONS IN THE LONDON CLAY.—Mr. P. Martin Duncan read an interesting paper on the Impressions of Selenite in the Woolwich Beds and London Clay.

The spaces formerly occupied by Crystals of Selenite occur in the Woolwich Beds, near Mottingham, Kent, and in the unfossiliferous London Clay of Tendring Hundred. Mr. Duncan described the various facts bearing on the question, including the conditions under which the beds were deposited, their chemical composition, and the mineral condition of the fossils, and discussed the explanations that could be suggested to account for the formation and subsequent disappearance of the crystals. He came to the conclusion that the mineral had resulted from the action of sulphuric acid, contained in percolating water, on pre-existing carbonate of lime, the sulphuric acid having been formed by the oxidation of sulphuretted hydrogen, by the oxygen evolved from the decomposing vegetable remains occurring in the Plant-beds intercalated in the strata containing these Selenite-spaces. The hydro-carbons resulting from the same decomposition would in solution be sufficient to produce the decomposition of the Selenite. Mr. Duncan mentioned that the occurrence of Selenite in a deposit must be held to prove the former existence of organisms in it, and the removal of the Selenite to be equivalent to the loss of the evidence of such existence; consequently, there can be no reason why the purest Clay-slate may not have been once as fossiliferous as the Woolwich Beds.

GEOGRAPHICAL SOCIETY.—*Dec.* 11.

DISCOVERIES, MADAGASCAR.—Captain W. Rooke communicated an account of a boat journey along the Coast Lakes of East Madagascar, having heard, whilst at Mauritius in 1864, that the chain of lakes south of Tamatave, in Madagascar, might be traversed for several hundred miles in a boat sufficiently light to be carried over the short portages, he determined to attempt their exploration. He had a boat constructed especially for the journey, and, with three

companions and a native crew, started for the northern commencement of the lakes in the month of April. The whole journey from north to south occupied the party thirty-two days, during which they travelled nearly 400 miles, partly over lakes of larger or smaller dimensions, but chiefly along winding channels and streams which connected the lakes together. The chain of lakes and channels occupies a belt of low land along the coast, and is sometimes separated from the sea only by banks of sand. The large rivers which descend from the high lands of the interior, are connected with the network on reaching the low belt of coast land. During the journey the travellers passed numerous villages and several large towns, some of which contained about 1000 inhabitants; their voyage terminating at Manzanari. They were well received by the Hova governors; they saw very little cultivated land, and the inhabitants seemed an indolent and improvident, but good-humoured race. The banks of most of the winding channels and lakes were clothed with magnificent tropical vegetation, which in the narrow watercourses arched overhead, and added much to the beauty of the scenery. At Manzanari they saw several individuals of the Akongo tribe, whose territory lies towards the south, and who have succeeded in maintaining their independence against the Hovas. Their capital is several days' journey south-west of Manzanari, and is situated on a high hill, the sides of which have been escarped for the purposes of defence.

The Rev. W. Ellis described Ankova the central province of Madagascar, and the royal or sacred cities it contains. The country is hilly or mountainous, but the elevations rise singly or in masses, rather than form continuous chains. Mount Ankaratra, in the south-west, is one of the highest mountains in the island, being about 13,000 feet above the level of the sea. It had not yet been ascended by a European, and probably not by the natives, although they stated that in the cold season snow lay in the hollows near the summit. Between the isolated hills or mountain masses lay fertile valleys or level plains, some of them several miles in extent. The province is well watered, and the rivers, though not large, seldom fail through the long droughts of summer. Forests border the province on three sides, and supply it with abundance of valuable timber, but the central district itself is almost destitute of trees. Flowering euphorbias and fruit trees had, however, been introduced, and grew luxuriantly. Horned cattle are numerous and increasing; and it is a singular fact that, whilst the domestic ox is the humped Indian species, the vast herds of wild cattle are all of the straight-backed kind. The sacred cities of Ankova are twelve in number; they derive their sanctity from having been the birthplaces, abodes, or burial-places of their monarchs. The belief in the influence of the spirits of the ancestors of their monarchs is one of the chief features of the Malagash religion; it enters into all their most important ceremonies, and influences the actions and policy of royalty. Europeans are forbidden to enter the sacred cities; and although some of them are places of large size, they have not yet been laid down on our maps.

ZOOLOGICAL SOCIETY.—*Dec.* 12.

The Gular Pouch of the Great Bustard.—Mr. Flower, the curator of the College of Surgeons, exhibited a beautifully dissected specimen of the gular pouch of the great bustard, the *Otis tarda* of Linnæus. This pouch, which is capable of holding several pints of fluid, is situated under the skin in front of the neck, and communicates with the cavity of the mouth by an opening beneath the tongue. The use of this singular structure is very problematical, it has been stated that it is employed by the male bird for the purpose of conveying water to the female during the period of incubation, but as the males entirely desert the females at this period the explanation is evidently erroneous. In addition to the uncertainty respecting its use, the pouch of the bustard possesses a peculiar interest from the circumstance that its very existence has been denied by many naturalists, even after having been figured in many of the olden books, such as *Daniel's Rural Sports*, and even in *Yarrell's British Birds.* Messrs. Mitchell, Newton, and even Mr. Yarrell himself, in a communication made to the Royal Society, denied that such a structure existed in the specimen they dissected. It is difficult to reconcile these contradictions. It may be supposed that the pouch only is developed at certain seasons of the year, but this supposition appears untenable. Dr. Gray suggested that two distinct species had been confounded together under the same name, one possessing the pouch and the other destitute of this singular appendage.

NOTES AND MEMORANDA.

Effects of Freezing Animals.—M. Pouchet has sent a paper to the French Academy on the effects of freezing animals. He finds that no animal really frozen is susceptible of revivification, as freezing disorganizes the blood. The temperature at which the death of insects, grubs, and snails becomes inevitable, is far below the freezing point (from 7° F. to —2° F). Animals may be surrounded by ice without themselves being frozen, unless the temperature is very low. M. Pouchet states, that when an animal is frozen, the capillaries contract so as to prevent the passage of the blood, and the nuclei of the blood corpuscles escape from the envelopes, and become more opaque than in a normal state.

Animal Grafts.—M. Paul Bert informs the French Academy of fresh experiments in grafting the tails of rats upon other rats. He finds that his curious process has succeeded after certain tails have been removed from the animals to which they belonged, and placed under the following conditions: 1. Exposed to the action of air in a closed tube for 72 hours, at a temperature of 44° to 46° F. 2. After exposure to a humid heat of 135° F. 3. After exposure to a temperature of 3° F. 4. After complete desiccation. 5. After complete desiccation, and exposure to dry heat of 212° F. The so-called "complete desiccation" was effected in *vacuo.*

Course of Hail Storms.—M. Becquerel has a paper in *Comptes Rendus* on a chart of the hail storms in the departments of Loiret and Loire-et-Cher. The storms seem to be of two kinds, periodical and irregular, the latter being the most violent. These storms, and especially the periodical ones, follow the course of rivers and valleys, usually avoiding forests.

Temperature of Polar Sea.—M. Charles Martins details in *Comptes Rendus*

experiments made during the voyage of the "Recherche" to Spitzbergen, which contradict the supposed increase of temperature in the depths of the polar sea. Employing thermometers with the bulbs protected against the pressure of the water, they met with no case of the kind. He found very little difference between the temperature near the surface, and that of various depths down to 870 metres.

CONSUMPTION BY INOCULATION.—M. J. A. Villemin states in *Comptes Rendus* that he has in several instances produced tubercular disease in the lungs and intestines of rabbits by introducing beneath the skin of their ears small quantities of tubercular matter from a patient who died of consumption.

SOLAR ECLIPSE IN CHILE.—The *Astronomische Nachrichten*, No. 1555, contains a long letter from Louis Grosch, detailing observations made at Santiago de Chile during the solar eclipse, 25th April, 1865, and accompanied by a drawing. We translate the principal passages in his *resumé* of what occurred. "The greater part of the sky was covered with cirrus and stratus cloud. Before the beginning of total eclipse, the sun disappeared behind thick stratus. Before the emergence of the sun, the protuberances (red flames) appeared like a serrated border. The protuberances altered in colour from carmine to cherry red: on the moon's edge the colour was yellow. Before the bursting forth of the first sun ray, there appeared from the heretofore sharp circular moon rim, serrations with three greater projections. During the whole time of total eclipse, the dark disk of the moon was sharply defined, and only surrounded by a milk white corona. In the western part of the corona, one spot marked in the drawing was for a moment very strongly illuminated, as if a bright pencil of sunlight streamed behind the moon at this spot. The protuberances extended in a curve about 60°. The highest point of the protuberances was 0·13 of a division of the micrometer (*eines Theiles des mikrometers*). The protuberances were seen for 2½ to 3 seconds." In another passage he says, that when the coloured appearance of the protuberances vanished, thin dark projections appeared to start forth from the moon just where the protuberances were highest. Were these, he asks, lunar mountains? They appeared and vanished in a moment, and if mountains must have been of true sugarloaf form. In *Comptes Rendus*, No. 22, 1865, will be found a letter from P. Secchi, with extracts from letter of P. Capellotti, giving his observations on the eclipse of 25th April (which he dates 15th April). He writes from Conception, Chile, and says, "The first impression I received after the disappearence of the sun, was that of an immense mountain of fire, like a rose coloured horn, at 57° from the zenith towards the W." This was seen while the eclipse was total, that is for 2m. 22s. Almost diametrically opposite to it was a smaller one of the same shape, and of a somewhat lighter colour. About 38 seconds after this, coloured flames appeared, so that the sun seemed to be on fire. It looked as if a train of powder caught fire in rapid succession. This rose coloured arc was 90° broad. When the sun disappeared, three bands of light showed themselves in a direction perpendicular to the moon's border. The most luminous was so brilliant, as to dazzle the eye applied to the telescope, and in the same position as the great protuberance; with this peculiarity, that on its western side it was cut straight like a prolongation of the lunar diameter; on the other side it was bounded, not by a curve, but by an inclined line. The darkness was greater than he expected, and was increased by a fog. "An iridescent arc appeared at a distance of more than 30° from the sun, and disappeared when the eclipse ceased to be total. This arc had the form of a crescent, its extremities resting on a line tangential to the lower limb of the sun. Several stars of first and second magnitude were seen during the darkness." P. Secchi remarks on the novelty of this arc, and cannot suggest an explanation, except by supposing it due to a fog in the sun's atmosphere. With reference to the bright bands of light, he asks whether such rays may not be seen on other occasions, and he states that on the 8th August, M. Tacchini being at sea, noticed a double jet of light after sunset, which followed the sun and seemed to belong to him. On the same day, P. Secchi observed on the sun a large facula, the upper part of which was very brilliant, and terminated in two jets like two leaves, which he considers may have been the very objects seen by M. Tacchini under different circumstances.

THE CLASSIFICATION OF MOLLUSCA.—In the *Annals of Natural History* is a paper by Dr. O. L. Morch on the "organs employed in the classification of the

Mollusca." He attaches great importance to the heart and to the organs of reproduction. He says, "The development of the young is of less systematic value than is generally believed: this is proved in the Crustaceans, the marine species having a larval form very different from the fluviatile species (*Astacus fluviatilus*, *A. Marinus*)."

TEMPERATURE AT WHICH PLANTS GERMINATE.—M. Alp. De Candolle read at the August meeting of the *Société Helvetiques des Sciences Naturelles* a paper on the above subject, detailing the results of many experiments. We extract a few particulars from the *Archives des Sciences*, No. 95. "White mustard (Sinapis alba) will germinate below 0° (the freezing point of the Centigrade scale); a flax plant (Lepodium) germinated at a mean temperature of 1°·8 C., rather more than 36° F. Collomia does not germinate below 3° C., but will do so below 5°·3 C., or just below 42° F. Nigella, Iberis, and Trifolium repens did not germinate at the last named temperature, but did at 5°·7 C. Maize germinated below 9° C. or 48°·2 F., but not below 5°·7 C. Sesamun germinated at 13° C., or 55°·4 F. Melon seed would not germinate at 13° C., but did below 17° C., or 62°·6 F. Seeds will not germinate above certain temperatures, varying with their species and the amount of moisture present; thus the greater part of some Trifolium repens seed did not germinate above 28° C., or 82°·4 F. Thus seeds only germinate between certain limits of temperature, and those which can only do so within narrow limits are least able to extend themselves geographically. Seeds of the same kind and origin will sometimes germinate in succession and not simultaneously. M. De Candolle says, that germination may be explained without any reference to "vital force," which he "leaves to the poets." The actions are, he states, "solely physical and chemical;" "the young plant in the seed, is like a prisoner confined in a small space. Physical and chemical causes enlarge the boundaries of its prison, render them flexible and permeable, and sometimes transform encumbering matter into nutritive liquids." If these operations proceed with neither too great nor too little force the plant grows.

THE TEMPERATURE OF BIRDS.—Dr. Davy has an important paper on this subject in *Proc. Roy. Soc.*, No. 78. He thinks that the respiration of birds is less active than is commonly supposed, and their high temperature is maintained by their warm clothing, and by the small loss of heat they experience through pulmonary or cutaneous evaporation, which is small in their case.

FOOD OF LARKS.—In the paper just mentioned, Dr. Davy states that he has always found grass in the gizzard of larks in the winter, and he regards it as their chief food at that season.

"THE EARTH IN THE COMET'S TAIL."—Our readers will recollect this was the title of a paper in our vol. i. p. 63, in which Mr. Webb furnished, from his own observations, reasons for corroborating the conclusion arrived at by Mr. Hind, that on the evening of June 30th, 1861, or a little earlier, our earth was in the tail of the comet then visible. M. Liais at the same time thought we had actually passed through the second tail of this comet. He now states, in *Comptes Rendus*, that more complete calculations confirm this belief. He computes that the axis of the second tail of the comet must have cut the earth's orbit at 6h. 12m. 10s. in the morning of the 30th June, at Rio Janeiro, and at that time he considers that we were plunged 110,000 leagues deep in the tail. From the velocity of the earth's motion he estimates that our entrance into the tail was four hours earlier. Rio Janeiro is in long. 43° 7′ 15″ west of Greenwich. M. Liais adds that if, as certain European observers thought, the tail was a little curved, we might, instead of simply passing through it, and across it, have moved for some time in the direction of its long axis. The breadth of the tail he estimates at 878,000 leagues.

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HARRILD, PRINTER, LONDON.